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ABSTRACT

This book contains reports of two projects--one in Ethiopia, one in Palestine--that integrated a Geographical Information System (GIS) into the educational planning process. (A GIS is a computer program that combines two databases: numerical data such as traditional data on schools, teachers, and students; and geographic data such as the location of schools, district boundaries, and topographical features.) The report on the Ethiopian project describes what a GIS consists of and how it works; explains how the GIS can be used to aid decision-making; and relates how a GIS on schools and education had been set up in the face of the many challenges in a developing country. The report on the Palestinian project describes how the GIS on schools and education had been established with the Palestinian Ministry of Education and demonstrates its functionality. It also discusses the structure of the GIS and its applications for educational microplanning; the difficulties in establishing the GIS and barriers to the appropriation of GIS by the ministry; and some of the beneficial outcomes of the project on planning and management functions. Text in both reports is supplemented by tables, figures, and colored maps. (WFA)

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Improving Micro-Planning in Education Through a Geographical Information System: Studies on Ethiopia and Palestine.

Ian Attfield
Mathewos Tamiru
Bruno Parolin
Anton De Grauwe

June 2002

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IMPROVING MICRO-PLANNING IN EDUCATION THROUGH A GEOGRAPHICAL INFORMATION SYSTEM.

STUDIES ON ETHIOPIA AND PALESTINE

Ian Attfield, Mathewos Tamiru, Bruno Parolin, Anton De Grauwe

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UNESCO

International Institute for Educational Planning

School mapping and local-level planning

Improving micro-planning in education through a Geographical Information System

Studies on Ethiopia and Palestine

Ian Attfield, Mathewos Tamiru, Bruno Parolin, Anton De Grauwe

International Institute for Educational Planning

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INTRODUCTION

Some background

Decentralization is a buzzword these days in public management as a whole and in educational management in particular. A growing number of countries – developed as well as developing – have decided to transfer crucial planning and management decisions to lower levels of the administration, such as regional or district offices. Discussions about the merits and risks of such a policy are plentiful and at times characterized by controversy. However, there is one issue on which all researchers and practitioners agree: for such a policy to be successful, decentralized authorities need a strong and relevant database to guide their decisions and to monitor the achievement of their objectives. At the same time, central decision-makers and planners also require regular information to monitor the progress made by different regional or district offices and, if and where necessary, to intervene so as to ensure an equitable development of the education system.

However, making data and information available to education officials does not guarantee that they will be used in decision-making. In education, as in other fields, the relationship between information producers and decision-makers is an uneasy one. The ultimate aim of information is to guide and influence the choice of decisions, but many decisions are taken without reference to the available data. This is due to various reasons, but not to what might seem the most obvious one, namely the lack of data. In every country, much time and effort is spent on data collection. All schools regularly fill in detailed questionnaires and school principals complain much more about the all too regular requests for data than about a lack of demand for such information. Most district offices keep copies of school questionnaires and have cupboards full of school and teacher files.

This rather paradoxical situation – plentiful data which are seldom used – finds its explanation in several factors, such as:

- the poor quality of some data;
- weak skills in data archiving and analysis;
- the lack of knowledge and experience with tools which are useful in managing and analyzing the data.

Not the least important factor resides in the way these data are made available: they are poorly presented, out of date and lack analysis. Computer tools can be of use in overcoming these weaknesses and in bridging the gap between information and decisions. One such tool is a Geographical Information System (GIS). A growing number of Ministries of Education are relying on a GIS to strengthen their management information system, but its full potential to improve educational planning and management at central and at decentralized levels has not yet been exploited.

The two studies contained in this volume relate the experiences of two projects, whose main objective was the integration of a Geographical Information System into the planning process by the educational administration, in Ethiopia and in Palestine respectively. This introduction comments upon the lessons learned from these two experiences. A first version of these two studies was presented at a meeting at the IIEP in Paris in July 1999. Several experts discussed the implications of these and some other experiences, in particular in Argentina, England and France. This introduction therefore also makes reference from time to time to the conclusions from that meeting.[1]

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1. A few other documents were presented at the IIEP experts' meeting, some of which have been published. These include:
- Clarke, G.P.; Langley, R. 1996, A review of the potential of GIS and spatial modelling for planning in the new education market, in: *Environment and Planning C: Government and Policy*, Vol. 14, pp. 301-323.
- Mendelsohn, J. 1996, *Educational planning and management and the use of Geographical Information Systems*. Paris: UNESCO/IIEP.

Before examining and discussing the use that was made of a GIS in Ethiopia and Palestine, we will first examine what are the main characteristics of a GIS.

What is a GIS?

A Geographical Information System is a computer program which combines *two* databases. The first one holds numerical data and is as such very similar to the information base you will find in a programme such as Dbase or Access. In the case of an education system, these would be the 'traditional' education management data on schools, teachers and students. The second database files geographic data, such as the location of schools, the boundaries of districts, the location of villages and cities, of roads, rivers and mountains, and other relevant geographical characteristics. The GIS links these two sets so that statistical data can be presented not only as tables and graphs but also as maps, which helps the reader to look for spatial patterns.

This makes for a broader analysis, so that quick and accurate answers can be given on questions as varied as:

- which regions are the most disadvantaged and do such factors as language, ethnicity or road infrastructure offer explanations?
- where can in-service training best be organized to serve the schools with the least-qualified teachers?
- which primary schools should first be upgraded to secondary to allow for increased access for the greatest possible number of primary-school leavers?

The non-published documents include:

- Attfield, I. Experiences of GIS in educational micro-planning.
- Chenier, J.P. Improving educational micro-planning through the use of a Geographical Information System: examples from the Académie d'Aix-Marseille.
- Mendelsohn, J. Recent experiences and observations on the use of GIS for educational planning.
- Mejer, F. GIS applications in planning education: Buenos Aires educational system, Argentina.

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One particular advantage of a GIS is that it allows for inquiries at different levels, by changing the unit of analysis from 'school' to 'district' or 'region'. The user can indeed zoom in on a map to examine one district with its different schools, or zoom out to look at the whole country with its distinct regions. It is thus in principle as useful for central level as for local-level planners.

This flexibility of a GIS is made very clear in the case study on Ethiopia. The thematic maps which cover the whole country allow for a more precise identification of disparities between regions and, at the same time, offer a more attractive presentation than tables or graphs would do. This is particularly relevant information for central-level decision-makers and for the regional offices which can compare their own situation to that of their colleagues in other regions. But these regional offices also need data on the situation of their districts, or *weredas* as they are called in Ethiopia. By zooming in on one region, the map starts showing the differences within the region, between districts and information becomes available which helps regional planners to identify the particular needs and characteristics of each district. Such zooming can continue until the map concentrates on the immediate neighbourhood around the school. This was done in the project in Palestine, in order, for instance, to help decision-making about the possible extension of schools.

GIS: its potential use

In educational planning and management, a GIS can be used for many different purposes, four of which are particularly important.

Firstly, it helps to make the presentation of data more attractive. One expert at the IIEP meeting indeed commented somewhat provocatively that his office's main reason to acquire a GIS lay in the fact that both the public and his own chief like coloured maps. The

point is less superficial than it sounds: information which is easier to read and interpret, and enjoyable to examine, is more useful than a dry set of statistical tables. The French Ministry of Education has therefore published for a number of years not only a yearly booklet of indicators with tables and graphs on the state of the education system, but also a 'Geography of the school' which contains a series of maps showing regional differences and disparities. Such geographical information is not only more useful for decision-makers, but can also help in raising awareness around particular problems.

Secondly, translating data into maps helps in recognizing 'unexpected' situations, which need closer examination. In Ethiopia, data on the evolution of school enrolment were mapped, with information for each single school. Some schools saw their pupil numbers decrease, others experienced increases. Nothing strange about that. But, once the data were put on a map, it appeared that a few schools were irregular: they did not at all follow the pattern of the surrounding schools. A closer investigation revealed that some data were inaccurate, an almost unavoidable occurrence in data collection on schools. In a few other cases, however, the enrolment increase of a particular school within an area characterized by an overall drop in pupil numbers was the result of the good reputation of that school. Such data checking could also have been done through a careful examination of tables and graphs, but that would not only have been more time-consuming, but less comprehensive, as geographical factors would be less apparent.

The *third* use of a GIS is that, through considering geographical factors, the analysis becomes finer, more precise and the ensuing strategies probably more pertinent. The work in Ethiopia, for instance, showed, in certain parts of the country, a clear relationship between the distance which separates villages from schools and enrolment ratios, particularly those of girls. The distance is not just expressed

as a straight line between the village and the school, but it is possible to take into consideration the road network. For schools with a preoccupying low girls' enrolment, the planner can zoom in and examine in more detail the geography and the school's environment. In Palestine, the development of the GIS helped in clarifying the somewhat irrational distribution of primary and secondary schools and in identifying where school construction was most needed. While it was always known that the location and distribution of primary and secondary schools was not efficient, the GIS enabled clear figures and prepared maps to demonstrate the extent of this problem.

This brings us to the *fourth* possible use: assisting in prospective planning. Several examples were given. Researchers in England use a GIS to examine the potential influence of a school closure on enrolment in the surrounding schools. This is a crucial issue in England, where schools need to be closed or merged, in certain areas because of a decrease of the population of school-going age and, in some exceptional cases, the continued under-performance of certain schools. The closing of a school is not just a traumatic experience for the teachers, students and their family, but can have serious implications on the whole social environment. For an educational planner the central issue, however, concerns the impact on the surrounding schools and the possible need for extra teachers or even classrooms.[2] In other countries, where the expansion of primary education has led to a growing demand for secondary, the emphasis will be more on using a GIS to consider the potential locations of secondary schools, their catchment areas and feeder schools.

Those countries which have introduced a GIS in their Ministry of Education are indeed relying on it to make the presentation of indicators more colourful, to make data collection more accurate and

2. Clarke, G.P.; Langley, R., *op. cit.*, 1996.

to analyze disparities between regions. Using a GIS for prospective purposes however is still an exception. At the same time, in a very few countries, regional or district offices have access to a GIS and use it regularly. The studies on Ethiopia and Palestine confirm this: departments within the Ministry have encountered relatively few problems when they start using a GIS, with the initial help of an outside consultant, but spreading its use to decentralized levels is much more challenging. The studies also pose the evident question of sustainability, and the responses are not unanimously positive.

The main constraints and how to overcome them

This raises two questions: what are the main constraints on the integration and widespread use of a GIS in educational planning at different levels; and, secondly, what are the implications especially for developing countries, which desire to use a GIS to improve educational planning, especially at micro-level?

The discussions at the IIEP experts meeting and the two studies in this book lead to the conclusion that developing and exploiting a GIS encounters several constraints of uneven weight, but which – in particular in developing countries – are more of an impediment at district level than in the central office.

These constraints can be listed under *five* factors. *Firstly*, the creation of any information system implies several *technical* steps (data selection, collection and input, data checking, integration, storage, updating and reporting). In the case of a GIS, because of the complexity inherent in collecting geographical data, this technical process is still more intricate. However, the experiences in Ethiopia or Palestine showed that finding computerized data on the location of rivers, villages, electricity lines and so on was actually less difficult and time-consuming than originally thought. This is one of the more

optimistic lessons to be drawn from these two projects: spending some time on contacting other ministries (especially those responsible for infrastructure and agriculture, not to mention the military) and researching among international agencies is a wise investment, as they have at times various computerized geographical data. Other experiences in Argentina, Cambodia or Namibia confirm this. Without doubt, the whole technical work of setting up a GIS should remain the responsibility of a central unit. Some of the data collection, especially relating to the location of educational institutions, probably has to be done in co-operation with the district or even village authorities. In Ethiopia, secondary-school graduates were able, after some short training on the use of a GPS, to collect the necessary school-related information without major mishaps. This also appeared to be a cost-efficient solution.

A *second* constraint concerns the *cost* of the hardware, the software and the staff needed for setting up the system. There again, this is hardly insurmountable when the system is limited to the central or regional levels, but becomes more of a headache when a network of districts needs to be served. In both Ethiopia and Palestine, the cost of material resources was not felt to be a serious problem, in part because only the central level and a few selected regions or districts were served. In the long term, and even when GIS use will become more widespread, expenses on hardware and software might not be too much of a constraint, especially in view of the current and apparently ongoing decrease in their costs. But the issue of staff is more vexing. Expertise in the use of a GIS is still a rare commodity, especially in developing countries, and it might be difficult to keep such staff within the public service, if salaries are much more competitive in the private sector.

The *third* constraint is *institutional*: which existing units or departments should manage the geographic information, or should

new units be set up? The solution found in Ethiopia was very different from that in Palestine. In Ethiopia, there was no doubt that a GIS should be seen as a component of an overall EMIS and, as such, the staff members in charge of EMIS were given the necessary training and became responsible for the GIS. This led to a full integration of GIS in the EMIS department. It was their task to make the relevant information available to the main users: the planning departments at central and regional levels. In Palestine, however, two departments felt that the development of the GIS was part of their mandate, because both needed the information coming out from that system. The General Directorate of Building and Projects was interested, for instance, in data on the need for school reconstruction and expansion, while the General Directorate of Educational Planning, Research and Development needed data on the distribution of teacher resource centres and their outreach to different schools. Solving this issue took quite some time and effort, and the project's implementation suffered somewhat. Finally, however, a mutually beneficial solution seems to have been found. The Planning Directorate undertakes all analytical GIS operations associated with existing and future school planning, while the Building Directorate implements the information in order to manage the rehabilitation, construction and expansion of schools in Palestine within the context of multi-year education plans. The GIS introduction has actually resulted in the establishment of new linkages between these two directorates, which offers good hope for the sustainability of the project. It is advisable, nevertheless, where an EMIS is functioning well at central, regional and district level, to include a GIS within the EMIS department.

Fourthly, ensuring that a GIS be used by district staff implies that such personnel should be *trained*. The meeting in this regard drew a distinction between training in the development of a GIS (which is complicated and could be limited to a few experts at central level),

training in the use of the system (which is more straightforward and could be offered to district staff with sufficient computer experience) and training in the use and interpretation of the system's products, i.e. the maps (useful to a much wider group of people). Both projects gave much attention to training but found it easier to build the technical capacities of the central-level staff, most of whom already had extensive computer experience, than to train decentralized personnel in using and interpreting maps. Within the Ethiopian project, at a certain moment, some technical training for regional staff was followed up immediately by a workshop on using the data for micro-planning. Participants considered this a useful combination.

This is linked to a *fifth* constraint, which one expert called the need to develop *spatial literacy* among education staff who show a lack of interest or awareness in the geographic dimensions of planning and management. Some experts therefore argued that promoting demand for the products of a GIS is as much a priority as pursuing its technical development. Indeed, it becomes clear from reading especially the Palestinian experience that it is crucial for any plan to develop a GIS to create interest in its output through demonstrating its usefulness and added value. This is a well-known theme in discussions about information and decision-making. A virtual cycle needs to be created: the development of useful and attractively presented information will lead to more demand for such information and to more resources for those in charge of an EMIS. The first step in the creation of such a virtual cycle lies in making sure that decision-makers and other possible users understand and appreciate maps. That is a long-term process, going beyond one single project.

An appropriate model?

In view of these different constraints, a model seems to have been elaborated in several developing countries whereby a GIS is set up

only at central level as part of the EMIS and whereby the products of the GIS are made available to the districts. These products can take the form of paper maps (in Cambodia and Ethiopia) or, more ambitiously, can be the database itself, transmitted either through the Internet (in the province of Buenos Aires) or via a CD-ROM (as was tried, with limited success, in South Africa). While such a model is attractive, taking into account as it does several of the above-mentioned constraints, it raises a more complex issue. Educational micro-planning has to be participatory and the decision of locating a school needs to be taken at the local level, in close consultation with the communities concerned. When a GIS is set up and managed centrally, the risk exists that decisions concerning the district level will also become more centralized, with an ensuing loss in ownership and relevance of those decisions. The persisting challenge therefore is to integrate the valuable contribution of a sophisticated tool into a decision-making process which emphasizes negotiation and ownership.

Anton De Grauwe

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SETTING UP AND USING A GEOGRAPHICAL INFORMATION SYSTEM FOR MICRO-PLANNING AND SCHOOL MAPPING IN ETHIOPIA

Ian Attfield, Mathewos Tamiru

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CHAPTER 1
INTRODUCTION

INTRODUCTION

This monograph discusses issues related to the use of a Geographical Information System (GIS) within the education sector of a developing country, namely Ethiopia. The paper has three aims, namely:

- to demonstrate what a GIS consists of and how it works;
- to explain how this GIS can be used at present to improve decision-making on education and what impact this has had on the structures and management of the Ministry of Education and the education offices at different levels;
- to show how a GIS on schools and education has been set up in a developing context, to describe the difficulties encountered and the strategies used to overcome these difficulties.

A brief overview of Ethiopian education[3]

Until the fall of the Socialist Government in 1991, the history of the Ethiopian education system could be studied in terms of several distinct historical periods, each having unique characteristics and challenges of its own. Beginning at the introduction of Christianity to Ethiopia in around 400 AD, there was a long tradition of religious education in the nation that remained influential up to the nineteenth century. In those days, the church and the mosque were the only seats of learning. During the nineteenth century, a demand arose to have individuals with a capacity to manage the various institutions dealing with international affairs. This led to the secular education system being established; Menilik II School was opened in 1908 and this was

3. Ethiopia uses a calendar about 7 years and 8 months behind that of the international Gregorian calendar. When used in this paper, Ethiopian calendar dates are qualified with E.C. Thus 1998 = 1990-1991 E.C. Prices are quoted in United States dollars ($), converted where necessary from the Ethiopian birr at the mid-1999 exchange rate.

followed by the establishment of a Department of Education in 1909. Efforts to expand secular education were halted between 1936 and 1941, during which time the Italian occupation affected the development of education in Ethiopia.

The real growth of modern education began after the end of the Italian occupation in 1941. There were also efforts towards the promotion of basic education in the non-formal sector, but with no significant result. Despite continued growth in enrolment rates, the actual number of children attending school represented a small fraction of the eligible school-age population. Access to schooling was limited primarily to the urban areas. The Emperor Haile Selassie did not systematically build the education system in the way many of the then colonial administrations did in neighbouring African countries.

Following the 1974 Socialist Revolution, mass education through formal schooling and national adult literacy campaigns became a priority concern of the then government, and led to an immense numerical growth in enrolment and a rise in the literacy rate to about 70%. However, after a number of years, the positive achievements of this regime started to wane. In many areas the civil war, which was fought against the military regime by a number of liberation movements, led to school closures. The victors of the civil war, who came into power in 1991, therefore faced severe challenges in education development, and during most of the 1990s enrolment levels did not rise to their late-1980s levels. The literacy rate has also seriously declined and is estimated at present to be 31 per cent; in other words: over two-thirds of the adult population (15 years and over) are illiterate. In recent years enrolment has again grown steadily, including in the more disadvantaged regions. The border conflict with Eritrea, which turned into a full-scale war at the end of the millennium, started some months after the project described in this monograph ended.

Notwithstanding the age-old tradition of education, Ethiopia faces many of the same problems encountered by other sub-Saharan African countries, and it is among the least developed countries in the world in terms of access to education at all levels. In general, low access and quality, an inequitable distribution of educational opportunities, inefficient administration and lack of adequate financing could summarize the condition of education at the present time. Addressing these issues, therefore, is the challenge faced by the present educational planners and policy-makers.

The present government's policies and priorities in education

The analysis of the current education policy in Ethiopia requires understanding of a number of different processes and issues. A new policy, which has a number of important features, has been developed. The new policy includes the restructuring of the system, the preparation of a more appropriate curriculum and a reform in management which gives more authority to the regions.

When the new education policy is fully implemented, the Ethiopian education system will offer eight years of primary education consisting of four years of basic primary followed by four years of general primary education. As a result the secondary level will become four years instead of six years in duration. The objective of basic primary education will be to provide literacy and numeric skills. General primary and general secondary will aim to give a graded general education in mathematics, language, social and natural sciences. It is envisaged that the last two grades of secondary will prepare students in appropriate subjects for tertiary education. The old regions, which were geographically based, have been completely redrawn to reflect ethnic groupings. New regions have a huge amount of autonomy compared to the previous government's highly centralized system. For administrative purposes the regions are

divided into zones and then districts known locally as *weredas*; education offices exist at each of these levels. The regions are now managing their own educational affairs and have the right to use their own languages for instruction at the primary level. The language of instruction at the primary level, which was previously Amharic, has changed to local languages where appropriate. The official school starting age in both the old and the new systems is seven years.

The Government of the Federal Democratic Republic of Ethiopia (FDRE) issued, in the second half of the 1990s, a comprehensive Education Sector Development Programme (ESDP) against the backdrop of Ethiopia's long internal conflict and the deterioration of the education sector. FDRE strongly believes that broadening access to education in a balanced fashion is central to the goal of promoting economic growth and the reduction of poverty. Hence, the overall objectives of the ESDP are based on the country's socio-economic needs for development. Accordingly, ESDP takes the issues of access, quality, equity, efficiency and financing at all levels as its major areas of focus.

The present Education Strategy focuses on the development of education over a 20-year period. During the current five years (1997-2001), the ESDP will focus on expansion of primary education, improvements in its quality, and a more equitable distribution of educational opportunities. More specifically ESDP identified the following objectives, to be achieved by 2001:

- expand access by raising primary enrolments from 3.1 to 7 million and achieve an average gross enrolment ratio of 50 per cent for primary education;
- improve the quality of education by extending the new curriculum to all levels of the system, increasing the number of certified primary teachers from 85 per cent to 95 per cent and lower the textbook ratio at the primary level from 5:1 to 1:1;

- increase efficiency by more effective utilization of teachers with an average pupil/teacher ratio of 50:1 and through a reduction of the number of drop-outs and repeaters;
- improve equity by achieving a gross enrolment ratio for primary education of at least 25 per cent in under-served regions, with a national target of 50 per cent;
- raise the share of girls in primary schools from 26 per cent to 45 per cent and increase the number of female teachers from 26.2 per cent to 35 per cent;
- increase financing for education by raising public expenditure on education from around 3 per cent (over the past decade) to 4.6 per cent of the GDP, while at the same time relying increasingly for new school construction on non-governmental institutions and introducing cost sharing at the tertiary level.

In line with the above objectives, the following *Table 1* compares some suggested indicators in 1996-1997 to targets for 2001-2002, and to the situation in 1999-2000.

Table 1. Suggested indicators and targets

		Situation	Target	Situation
	Suggested indicators	**1996-1997**	**2001-2002**	**1999-2000**
Access	Gross enrolment rate, total primary (1-8)	34.70%	50.00%	51.00%
Quality	Student textbook ratio (Student per set) primary	5:1	1:1	2.5:1
Efficiency	Student/teacher ratio			
	Primary	42	50	64
	Secondary	35	40	41
	Student section (Classroom) ratio			
	Primary	57	50	70
	Secondary	66	40	57
Equity	Gross primary enrolment rate in under-served regions	17.8%	25.0%	
	Female primary participation rate	26%	45%	
	Percentage of primary school female teachers	26.2%	35%	

As is clear from *Table 1*, Ethiopia needs to expand enrolment while at the same time improving quality. There are also serious problems of repetition, drop-out and internal efficiency. According to the 1996-1997 statistical abstract of the Ministry of Education, of the 1,000 pupils who started the cohort, 296 eventually graduate from the final year of the eight years primary cycle. There are large variations between regions and sharp urban-rural disparities in enrolment, as well as considerable gender differences in terms of participation and completion rates.

The government is financing ESDP through a novel partnership with a multi-donor consortium that consists of the World Bank, international agencies and bilateral donors. A lot of the funds are allocated down from the central level for regional implementation. Also many of the donors are assigned to work directly with specific regions in particular education sectors. The education mapping activities reflects this: a national school mapping study for ESDP was funded by the World Bank's PHRD (Policy and Human Resource Development) project office, while regional micro-mapping campaigns have been funded by bilateral donors working in those regions (USAID for the Tigrai and Southern Nations, Nationalities and Peoples (SNNP) regions, Finnida for the Amhara and Benishangul-Gumuz regions).

School mapping objectives

The general objective of school (education) mapping is to improve the education system at a local level, by providing information with a geographic dimension which will enable local-level planners to make better-informed decisions. Of particular relevance to Ethiopia in its current education expansion programme of ESDP is to identify and illustrate current inequities and the related issue of where to undertake school building or upgrading.

A first school mapping project, within Ethiopia, which relied on a GIS, had a quite limited objective: to illustrate intraregional disparities within the Tigrai region. This was undertaken at the suggestion of the USAID Basic Education System Overhaul (BESO) planning adviser. The Tigrai regional authorities, using BESO support, expanded the idea and decided to undertake a school mapping project for the entire region, with the aim of using the resultant information to assist in identifying priorities for the ESDP expansion. The project was generally seen as successful, and was expanded on request to three other regions. In addition, national-level studies and training have been undertaken. The school mapping project included the following activities:

- installation of computers with GIS software, accompanied by training of the technical staff;
- collection of school-location data;
- integration of collected data with other relevant information (on school enrolment, buildings and equipment, and so on);
- analysis of the collected information through producing maps which highlight specific problems or characteristics, using GIS techniques;
- provision of processed information to decision-makers involved in education monitoring and planning at all levels;
- promotion of inter-agency use of geographic information and resources.

It is envisaged that the school GIS will serve as an information reference tool that may be easily consulted via computer or printed maps. It will require annual updating to accurately reflect the constantly changing education situation across the country.

CHAPTER 2
USING A GIS ON EDUCATION

USING A GIS ON EDUCATION

This chapter starts off with a number of practical examples of how a GIS can be used in educational planning, based on real data collected in Ethiopia. We will first look at a very common use: developing thematic maps at a national level, to emphasize important issues. A second section explains how an analysis through GIS can facilitate micro-planning. A third section describes further possible uses.

GIS for thematic mapping

One of the most common and straightforward uses of GIS is to demonstrate regional inequities and disparities by using a technique known as thematic mapping. This implies that a map is produced which shows, for instance, the Gross Enrolment Ratio by region, with the regions highlighted in different colours. The specific advantage of a GIS is that it allows you to combine different criteria and to change the legend, so as to stress the needs and situation of particular areas. The technique entails altering display attributes (colour, size, symbol) of geographic polygons (region, district), according to a statistical criterion (enrolment, average score). Such maps present information in a manner which is easy to understand and allow a spatial dimension to be introduced that is not possible with tables or graphs.

This paper will comment later on two thematic maps related to the issue of enrolment at primary level and gender disparities, two issues of major concern to Ethiopia. Preparing such maps implies obtaining data on population and enrolment, and, more intricately, linking these to the regions on the map.

To obtain the population data, we followed a fairly straightforward process. Using the school-age population data from the census as a base, we made a projection to the present year for all of the regions.

In Ethiopia, school-age population is defined as 7-14 and 15-18-year age groups for primary and secondary school respectively. The school-age population projection was made separately for rural and urban areas. We applied the constant growth rates, used by the national census office, namely 4.11 per cent for urban and 2.23 per cent for rural areas. These data were available by sex.

Detailed data on enrolment exist within the Ministry of Education and these education and population data were compiled in an Access database to allow more flexibility in manipulation and revision of the information. The data file was then exported to MapInfo. It is also possible to open Access data tables directly in MapInfo and edit the data via a map display.

When importing data from a database into a GIS, it is essential to have a column in both databases which contains the same data and allows for both tables to be linked. In our case, the tables with data on primary and secondary education at regional level included an indexing field (with an ID number) to allow the data to be linked to files within the GIS with the geographic and administrative boundaries. The administrative boundary maps have all been prepared via digitization, a process by which paper maps are accurately translated into a digital format and then geographically referenced to allow zooming and overlaying with other geographic layers.[4] The thematic mapping capacities of the MapInfo software were then used to choose the required variables and to alter the regions' colours or the dimensions of the pie chart via the internal index that relates data tables to map objects. Several maps were prepared on a wide range of indicators, two of which are presented and discussed in the following paragraphs.

4. At the moment of the preparation of these maps, there was still no officially authorized map of Ethiopia's new administrative regions, five years after their introduction. For this reason it should be understood that the prepared maps display unofficial and approximate borders.

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Primary Gross Enrolment Ratio (GER) map

In 1996-1997, there were about 12.9 million children between the ages of seven and fourteen. The Gross Enrolment Ratio (GER) stood at 34.7 per cent. In other words, the number of students in schools represented 34.7 per cent of the total population between seven and fourteen, but this included some under-age and especially over-age children. There is a wide variation in this indicator between the regions, as indicated in Thematic Map 1: *Primary Gross Enrolment Ratio*. The GER ranges from 8.4 per cent to 80.3 per cent with Afar having the lowest and Addis Ababa, the capital city region, the highest.

Afar has the lowest enrolment rate for both boys and girls, with a total primary GER of 8.4 per cent. Somali follows with a GER of 11.6 per cent. Four regions have a GER of less than 40 per cent and are, at the same time, under the national average: Afar, Somali, Amhara and Oromiya. These regions should attract priority attention of planners and policy-makers. Only the capital region, Addis Ababa, has a GER of over 80 per cent, and two other regions, Harari and Gambella, score over 60 per cent. Gender bias in favour of boys is apparent in all regions, with the notable exception of Addis Ababa. In terms of equity of enrolment by gender, girls' GER is less than half of boys' GER in Somali, Oromiya, SNNPR and Benishangul-Gumuz. The data on the map show that the gap is less in Dire Dawa and Tigray. The national Gross Enrolment Ratio was 43.0 per cent for boys, compared to 26.0 per cent for girls at the primary-school level. If the map is studied in conjunction with a map layer of religion and farming practices, other patterns emerge. The nomadic eastern regions are seen to have by far the lowest enrolment rates, the Christian northern highlands have low enrolment with more equitable gender ratios, while the more Muslim areas to the south (Oromiya, SNNP) have higher enrolment but a lower proportion of female students. The map raises questions

that may not be apparent if the data are studied in isolation from the geography of the country.

Gender proportion of secondary students and teachers map

Thematic Map 2: *Gender proportion of secondary students and teachers* shows data on gender disparities among pupils as well as teachers in secondary-school education. It is regularly argued that there exists a relationship between the low enrolment of girls and the poor participation of women in the teaching force, and that recruiting more women could attract girls to schools. At national level, out of the total secondary enrolment, the proportion of female students was only 42 per cent. The more equitable gender proportion in urban regions (Addis Ababa, Harar, Dire Dawa) is to be expected, as overall social development is higher in the urban regions. This implies, for instance, that there will be less fuel- and water-collection chores to do which are traditionally assigned to the girls in rural Ethiopia. It is pertinent to note in this respect that the proportion of girls among students increases from the primary to secondary level; this may reflect the rural to urban shift in the location of secondary schools, as compared to primary.

The map also displays the gender proportion of secondary teachers through pie charts. At national level, only 8.2 per cent of secondary-school teachers are women. The proportion of female teachers shows variation with geography (broadly following female student proportion) and with the rural-urban divide. Addis Ababa has the highest proportion (14.4 per cent) of female teachers, while in Somali and Gambella only 1 out of 50 secondary teachers is a woman. A steep drop can be noted when comparing this variable from primary to secondary level. Use of the map helps to identify priority regions for action to deal with the trends described and justify funding allocations at the national level.

One important point to note when considering the thematic maps is that they are not fixed pictures or diagrams. The software allows for an 'interrogation' of the data through changing the selected indicators and the legend. At the same time, if the data table underlying the map is corrected or updated, the GIS will automatically update the display and can adjust the parameters, such as symbol size, to clearly illustrate the variable under analysis. As data over a number of years become available, chronological trends in education may also be studied through thematic mapping.

GIS for micro-planning

One of the most effective uses of GIS in education is to undertake micro-planning analysis by focusing on the local level (the district or *wereda* in Ethiopia). The methodology to collate and integrate the required information for this purpose is more demanding and time-consuming than for more general maps at a national level, because there is a need for more detailed and varied data. In brief it entails the collection of as wide a series of data as possible, including exact school co-ordinates, other accurate digital sets of geo-data (such as relief, rivers, road network), similar sets on social services (health centres, post offices) and school-level education statistics. The different geo-data sets are organized in layers, which may be thought of as maps printed on transparencies, which can be overlaid in any order. They can be magnified or reduced at will via the GIS. Layers can be 'turned on' or 'turned off', according to variables associated with that layer, and in function of the issue that is being examined. The maps, shown later, will offer examples of these procedures.

To be able to explore the educational characteristics of a particular area, the decision-maker/planner needs only elementary computer skills to navigate around the GIS if it is prepared in a suitable manner by technical staff. On opening the GIS, a map similar to *Map 3* can be

automatically displayed; in this case the map is of the Tigrai region of Ethiopia. By using the 'zoom' facility the area of interest can be selected and the screen magnifies this area. In this case the red rectangle is selecting parts of Samre and Abergele *weredas* in central/ southern Tigrai. As the zoom factor passes a pre-defined threshold, additional geo-layers start to appear, such as schools or roads. These are not visible in the initial view as the data would be so plentiful (e.g. all schools, roads and different labels) as to clutter the screen and make the map unclear. The outcome of zooming into the red rectangle of the displayed map results in a display similar to that shown in *Map 4*. By clicking with the mouse on a particular school or geographic feature, an information box appears that displays data variables associated to that geographic object, for example the school enrolment and available facilities. In this manner one can quickly become familiar with the education structure in a particular area and explore themes of interest at will.

In Ethiopia one would not normally find computers at education offices below the regional level, however many of the micro-planning decisions (new school locations, schools to extend or upgrade, etc.) are made at the zonal or *wereda* levels. To disseminate the education GIS information to these levels therefore requires the production and printing of standardized maps that are easy to understand and use. In Tigrai these maps focused on individual *weredas* and integrated data on individual schools with several geographic features and related attributes. The maps are relatively quick to produce as the data are prepared for the whole region at once; the technical-staff member then merely has to zoom to the required area, apply a little formatting and then print copies of that area. For each *wereda* three different A3-size maps, similar to those shown later in this section, were printed and copies distributed to the regional, zonal and *wereda*-level education offices. Feedback from zonal education officers in Tigrai was generally favourable. The maps had proved very

useful when planning meetings took place. Requests were made for additional copies and for poster-size zonal-level maps. Requests for map copies from organizations such as non-governmental organizations (NGOs) working in these specific areas, are now frequently received at the Ministry of Education in Addis Ababa.

Three illustrative maps of the same area (Samre and parts of Hintalo-Wajirat and Abergele *weredas* in central/southern Tigrai) are included and are described and discussed below. It should be stressed that these maps are only a few examples of what can be produced; virtually any variable known about the schools may be displayed with any combination of geo-layers.

School infrastructure and elevation map

Map 4: *School infrastructure and elevation* attempts to combine several indicators which are of use when planning which schools to upgrade and where to build new schools. The coloured background is based on a digital elevation model of the region, it gives an approximation of the terrain in the area, identifying the major mountains and valleys. The colours roughly correspond to a commonly used agro-elevation zone classification used in Ethiopia:

- Yellows *Kolla* 500 - 1,500 metres above sea level
- Greens *Woyna Dega* 1,500 - 2,500 metres above sea level
- Blues *Dega* 2,500 - 3,500 metres above sea level

Roads are categorized as having 'all weather' or 'dry weather' surface and the courses of rivers are displayed, together with other infrastructure and social services that include *wereda* education offices, wells, springs, health facilities and an approximate settlement distribution pattern. The latter should not be thought of as exact village locations, as in this area of Tigrai a scattered rural settlement pattern is the norm. *Wereda* (district) and peasant association (known as *tabia* in Tigrai) boundaries are also displayed.

The schools are identified with a symbol according to the grades currently being taught; this is important in deciding which schools to upgrade. Displayed are 1st cycle primary schools (Grades 1-4, black triangle), 2nd cycle primary schools (Grades 5-8, red circle) and primary schools that teach up to Grade 6 (pink square). The schools' labels denote the presence of water, building condition (A - E: Good - Bad) and the number of classrooms.

The new national education policy, which extends basic education to eight years, prescribes that as many of the existing primary schools as possible should be expanded to cover up to Grade 8. This map can be utilized to identify schools which can most easily offer the full eight grades: those currently teaching up to Grade 6 in good condition with access to roads and water, Tagiet, Melbe and Finarwa for example. Because of a concern with equity, and therefore to give better geographic distribution, the school in Adi-shash in the north of Samre, which teaches only Grades 1 to 4, may also be considered. At present there is no secondary school located in the map area. In Samre there are three schools teaching up to Grade 8, and Samre town would be the most likely site for a secondary school, but to maximize its use arrangements would be needed (transport or accommodation) for pupils completing Grade 8 in, for example, Gijet or Dengolat schools.

Building maintenance is obviously needed at many schools: some, marked as condition 'E', were teaching most or all classes in the open air. A water supply at Gijet and Dengolat schools may also be a priority.

School enrolment and gender ratio map

The objective of Map 5: *School enrolment and gender ratio* is to gain a fairly detailed impression of the situation of each school, as far as present enrolment is concerned, its recent evolution, the distribution between boys and girls and to link this to population

density by peasant associations (PAs). The PA is the lowest administrative unit for which census data are available. These PA units are coloured according to the population density. The GIS automatically calculates the area of each unit, then uses a simple formula to include the population from the database. The population density falls as the colour varies from pink to yellow to blue to green. Inspection of this trend identifies the highland area to the centre and east of the map as having the highest population density.

The school label gives the student enrolment (1989 E.C. relates to 1996-1997 in the western calendar) change over the past two years (negative values indicates a drop, 0 indicates a new school) and pupil/teacher ratio (PTR). The reasons for a large drop in enrolment at schools such as Adi-giba or Shewate-higum warrant further investigation. Gijet school is seen to have doubled in attendance over the past two years, with a new school Tashi built nearby (at present only Grade 1). The PA Addis Aleme between Waza and Atsgebta may thus be a candidate for a new school (high population density, rapidly increasing enrolment nearby) or the northern PA of Mariame Moko. Analysis of the PTR values shows most rural schools to be well below the national policy target of 50, an exception is Mai-Genet school in the north east that appears to be in need of at least one additional teacher.

The schools on this map are represented by a red/green shaded pie-chart, calculated by the GIS from the enrolment statistics. The proportion of red to green colour gives the ratio of male-to-female students. Immediately, schools such as Werk-tarbe or Adeba may be seen to have over 70 per cent male students, while Mai-kana surprisingly shows the reverse. It is also possible to vary the radius of the pie according to the total enrolment to give an immediate impression of school size (not shown).

Many school-related variables may be conveniently studied using GIS, with the advantage over analysis of tabular data that spatial relationships can be identified. For example, student gender ratio is generally seen to be equitable at schools situated close to roads, while boys predominate at more remote rural schools away from roads.

School catchment area map

Map 6: School catchment area has as its objective to offer an approximate picture of the enrolment rates for the catchment areas around schools. This demands, on the one hand, the creation of these hypothetical geographical areas around schools and, on the other hand, a calculation of their school-age population. To generate approximate school catchment areas, a new method was used: an algorithm known as a Thiesson polygon (Voronoi Tessellation) is run which generates areas or regions around each school that completely cover the geographic area of interest (perhaps zone or region). The algorithm calculates, for each point on the map, the nearest school and then groups the points sharing the same school into approximate catchment areas. This of course is an approximation to the truth and only considers distance, not natural barriers such as rivers or mountains.

A digitized population distribution map at the sub-*wereda* level (PAs) was used by the GIS in the previous map to calculate population density. It was based on the 1994 CSA census and has been corrected to be geographically accurate according to known landmarks. The GIS is used here to re-aggregate the population distribution from the sub-*wereda* units to the generated school catchment areas. It assumes a consistent population distribution over each geographic unit and assigns population by proportional area overlap. For instance if 50 per cent of one PA overlaps with a particular school catchment area, then 50 per cent of that PA's population is assigned to the school

catchment area in question. Using the *wereda's* population distribution by age, it is then possible to calculate the number of school-age population for each catchment area and derive a gross enrolment ratio (GER) for each school. It is evident that this method relies on a combination of hypotheses, the result being that the enrolment rates at which we arrive, are evidently inexact. This does not imply that the map is of no use, but rather that care is needed when interpreting and using the data. The map can especially be helpful when highlighting issues for further investigation.

The map displays the schools as circles with the colour representing the GER calculated by the above method; the GER is displayed as a percentage in the school label. For instance, Sesela school in the north east has a primary school-age catchment area population of 567 while around 20 per cent of this number actually attend. The catchment areas displayed have been colour coded to represent the approximate primary school-age population or 'population served' of each school. The value of this population estimate is printed in italics in the centre of each catchment area. Each colour trend uses: pink, yellow, blue, green as the variable decreases. Thus a green school in a pink catchment area indicates an area with a high number of children but few attending, such as Mai-kana or Adi-shashi in the north or Werk-tarbe in the west. The borders of the catchment areas are equidistant from the nearest schools; this is helpful information when selecting likely positions to construct new schools.

For instance, the border of the catchment areas of Fliek and Werk-tarbe schools in Abergele is over 5 kilometres from either school. A track does extend to this area from Werk-tarbe and, although remote, it does have a significant population. Referring back to the first of these three maps identifies this area to be the river border of Sraw

and Gerewer PAs, which is lowland, perhaps an unpopular site due to the risk of malaria. The settlement sites on the green (higher elevation) areas of the first map (northern Sraw PA or central Gerewer PA) may be more suitable.

Thus the set of three micro-planning maps together, in conjunction with other geographic data and local knowledge of the area, may be used to identify possible sites for new 1st cycle primary schools; a major objective of the current planning exercise being undertaken in all regions of Ethiopia. More and more detailed micro-analysis could be undertaken, such as plotting individual house and footpath locations. However, a point quickly comes when the benefit of doing so would be outweighed by the costs associated with the data collection and management.

Other uses of GIS in education

A GIS can be of use to answer a number of other queries. It would be interesting, for instance, to link the schools to the language spoken in the community. Policy in several regions in Ethiopia dictates the use of the mother tongue to teach in the first cycle of primary education; this of course has many planning implications in the development of curriculum, provision of textbooks and the availability of suitable teachers. The GIS has been used to associate the school to the language spoken and store the language code in the database containing the school information. The GIS can now be asked to undertake a spatial query that associates a point location (in this case, of the school) to the polygon (region or area) that contains it. It then calculates the total enrolment in the different schools in a certain language area, to gain information on the needs for teachers, textbooks and so on.

In Map 7, *Language and school distribution,* the actual distribution of schools (represented as dots), borders of the administrative zones

(black lines) and approximate language areas (red lines) for a section of the Southern Nations, Nationalities and Peoples (SNNP) region of Ethiopia are displayed. This region of Ethiopia contains a large number of ethnic groups, many of which speak their own distinct language. On the map the total number of schools in each language area is displayed, together with the approximate primary school-age population in that area. The actual number of pupils enrolled by grade in a language area may also be calculated via the GIS, as long as the enrolment data for the schools are known. The limiting factor in this example would be the accuracy of the language map; precision of data, as with all numeric disciplines, has to be taken into consideration when undertaking GIS analysis.

An important piece of information, when planning for the universalization of primary education, consists in knowing the numbers of children who are living far away from school. One way of doing so, is to generate school catchment areas, as was shown in the previous section on using a GIS for micro-planning. But there is a quicker, simpler, probably less precise method which, however, offers valuable data at a general level. The method consists of creating, through the GIS, circles of a fixed radius about each school point. Again this method does not consider differences in terrain (mountains, rivers, etc.), but it is a fairly realistic assumption in areas where schools are sparse as young children are unlikely to walk more than 10 kilometres each day to attend school. In Map 8, *Population within reach of a School,* the GIS has been used to analyze disparities of access to primary education between the *weredas* of Tigrai. An arbitrary value of 5 kilometres was used in generating circles around each primary school; in reality a smaller value is perhaps more appropriate as this distance is probably too large for a seven year-old starting school to walk each day. These circles were then merged into one multi-section polygon (shape) by the GIS and then split into sections, one for each *wereda* of the region. Such operations would

be extremely time-consuming to undertake using traditional cartographic methods. With GIS they are straightforward, making use of built-in editing facilities that automatically retain the geographic position and scale. The following step consists in calculating the population of these areas (shaded grey) for each *wereda* by summating the population from the PA map (refer to the previous 'School catchment area map' for the methodology). The population within reach of a primary school is then expressed as a percentage of the total population. (This again presupposes a fairly equal distribution of the population within a PA). The map demonstrates that in the more sparsely populated areas to the west there is lower accessibility to schooling than in the more densely populated areas further east. However, as schools are usually built in population centres a greater proportion of the population have access than the shaded area may suggest. For example, in Kafta Humera *wereda* only 10 per cent of the area is close to a school, but this 'close' area contains 44 per cent of the population. This method demonstrates the use of micro-level information (school locations and detailed population distribution maps) to accurately analyze the macro-level situation within the region with regard to the accessibility of primary education.

This section has demonstrated the ability of GIS to combine different data sets and produce useful results using spatial or geographic queries that cannot easily be replicated by conventional methods. However, the resultant maps do not always display the amount and variety of work that has been undertaken to attain this output.

An area which has not been explored (within this project) is the use of GIS in asset management. In numerous other sectors, a GIS has been relied upon to track the condition and locations of facilities and stock. The lack of asset data at the school level in Ethiopia has precluded this area from being pursued further at present.

Much of the data collected by the school mapping programme may also be utilized in other development areas such as health, land-use planning, food security, vulnerability assessment and local administration. Frequent requests for assistance have been made by organizations linked to these sectors in Ethiopia.

CHAPTER 3
SETTING UP A GIS ON EDUCATION: A TECHNICAL EXERCISE

SETTING UP A GIS ON EDUCATION: A TECHNICAL EXERCISE

Planning a GIS

When planning the introduction of a GIS within the educational management system, many factors that need to be considered will be common to the setting up of any technical information system. These would include the identification of technical goals, of the projected lifespan, a study of the operating environment, staff and training requirements, budget and logistics.[5]

The most basic requirements to start are a person with relevant technical skills, a computer and a clear set of objectives. In the design phase a study should be undertaken that reviews existing computer hardware, staff with respect to their current level of technical training, management needs and expectations and existing data availability. 'Peopleware' as opposed to hardware, software or data will always be the most critical component and the major cause of the GIS's subsequent success or failure. If the GIS is set up by an external consultant who then leaves without giving sufficient training to the organization's permanent staff, it is extremely likely that the system will collapse.

Based on the design phase, implementation may then begin with technical work, namely to install computers, train staff and collect necessary data. Clear goals and outputs should be set to ensure that the GIS does not operate in a vacuum and that useful output (especially in terms of display maps) is produced. When output becomes available, the use of it by planning staff, managers and decision-makers needs to be explored. This might demand that special

5. A more detailed account of issues related to planning an educational GIS is given in the book: "Education planning and management, and the use of GIS", John M. Mendelsohn. UNESCO publication, IIEP, 1996. The book also provides a very useful introduction to the fundamental concepts of GIS and how they relate to educational planning.

attention be given to training decision-makers in the use and interpretation of geographical information, while output might need to be adapted in order to meet needs and expectations.

Setting up a new system will necessitate baseline data collection. Once this has been achieved, the long-term sustainability and use of the system needs to be considered. Again, like most computer-based systems, the GIS will require regular updates, technical support and periodic reviews of its purpose and effectiveness. The setting up of the GIS should not be embarked upon if there is not enough support for the system within the organization's management and if clear responsibilities are not assigned within the organization's structure for its operation.

Hardware and software

The acquisition of necessary hardware and software for a GIS is not as complex as it may appear, despite the tendency of computer-based technology to evolve rapidly. An educational GIS is unlikely to need the resources that a land-use or urban planning system may need as the data requirements will be much smaller. A GIS may now be operated on a standard modern personal computer, which may already be available within the organization. At present IBM-compatible computers would be the preferred choice as they are ubiquitous in the business community and are easily purchased, upgraded, maintained and networked. Such computers were available, when the project was implemented, at a price of about $1,500 to $2,000.

In Ethiopia, computers with the necessary specifications were already available at the national level and in the larger regions, but were generally poorly utilized due to a lack of training. Many were only being used for word processing; thus, by using a GIS, the computers' additional capacity began to be exploited. Upgrades to memory and storage capacity may prove necessary as GIS software

tends to use a lot of processing and storage resources. If many users require access to the GIS a simple computer network is also a good idea. In Ethiopia, the Ministry of Education's Education Management Information System (EMIS) already had one that could be utilized. Useful accessories include an Internet link for data transfer and technical support, a digitizing tablet and/or scanner for inputting paper maps and a colour printer or plotter for producing high-quality output. In Ethiopia each region involved with the programme purchased an 'A3'-size colour 'deskjet' printer (around $1,200) for printing *wereda*-level maps. To accurately locate school locations, 40 hand-held Global Positioning Systems (GPSs) were purchased. These devices have dropped dramatically in price over the past five years to around $150 each, which makes them relatively affordable in numbers sufficient to cover large areas quickly.

Like hardware, computer software changes rapidly and a review of the latest available versions prior to purchase is advisable. Deciding factors include compatibility with existing software, 'ease of use' and training requirements. In Ethiopia Microsoft Access has already been used for some time within EMIS and thus was the obvious choice for database software. There existed already a base of users and local trainers and the software integrates well with the rest of the Microsoft Office software suite. Choice of GIS software was more open, as no such specific software was in use at the moment the project commenced. A number of windows-based GIS now exist that are relatively easy to learn and are aimed at 'desktop' mapping as opposed to more complex DOS-based systems that require much higher levels of computing experience. A recent review of current GIS software that would be suitable for school mapping is given in the book: *GIS for population statistics* (1997).[6] It also reviews a survey of GIS use in

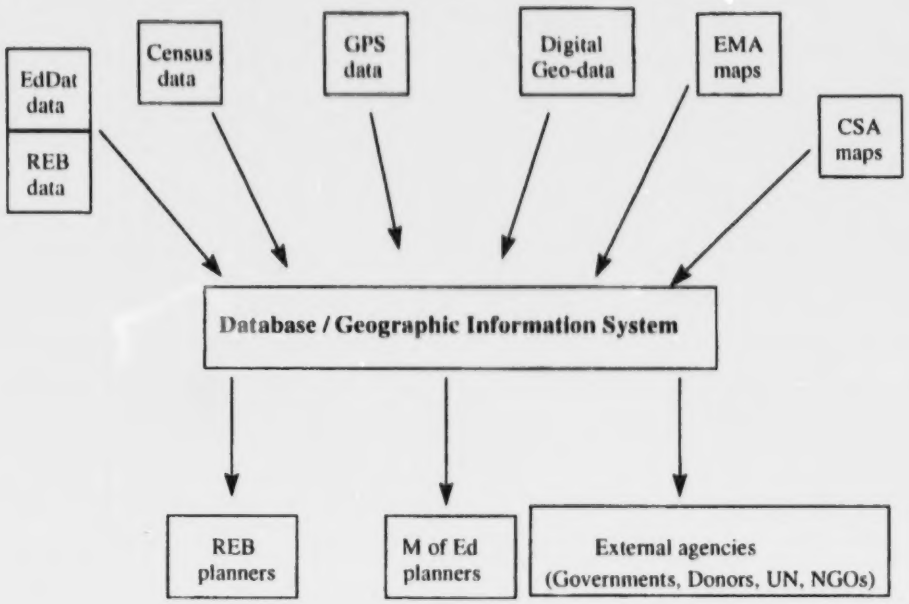
6. A United Nations publication, by the Department. of Economic and Social Information, Statistics Division.

national statistics offices and gives a good example of its use in the health sector for Nepal. MapInfo Corporation's MapInfo v4.1 software was chosen for use in Ethiopia due to its relatively low price ($1,200), its robust nature under the Windows 95 operating system, ease of use, functionality and good compatibility with other software. The other main competitor at present would be Environmental Systems Research Institute Inc. (ESRI)'s ArcView v3.0 software.

Data collection

As mentioned in the planning process, a vital component of the design phase should be a review of the existing and required data to match the needs of the system that we want to set up. This requires a good knowledge of different institutions operating in the country, such as the national mapping and statistics offices, international agencies, universities, etc. In Ethiopia the problem was not so much the knowledge of where information was, but in gaining access to it. Mapping data is often seen as sensitive for military reasons and officials can be reluctant to request information from other government institutions. The flow chart below illustrates the various sources of information used; it also shows the GIS in its operational context receiving and utilizing data to provide decision-makers with processed information for educational planning.

Ethiopia education mapping information flow chart



The flow chart's data sources include tabular data on the left, digital geo-data in the centre and paper maps to the right. The only new information that was collected for the school mapping programme were the actual school co-ordinates using GPS. There was no need to repeat the collection of other educational statistics at this level due to the adequate information provided via EdDat, the Ministry's Education Management Information System (EMIS) and via the Regional Education Bureaux. A population database down to the smallest administrative unit (Peasant Association, PA) was obtained from the 1994 census conducted by the Central Statistics Authority (CSA). The ability to relate population data to geographic location at the PA level was considered the most important geo-data requirement, after the locations of the actual schools. Fortunately for about half of the country's *weredas*, the paper maps produced by the CSA had already been digitized by projects run by the Ministry of Water Resources (in the framework of the river basin master plan). For areas not covered in that way, the CSA paper maps were purchased and

digitized by private commercial firms. It was not considered cost-effective to try to do this work internally. The cost for this work in the SNNP region was shared with a health-sector project that also realized the benefit the data would give it for health planning. Other geo-data collected included layers such as rivers, lakes, roads, elevation, health-facility locations, settlement patterns and *wereda* education offices. Their use is to put the school locations into context with their physical surroundings and to allow for the calculation of travelling distances. Most of this information was obtained freely from other organizations such as the river basin projects and from international agencies (WFP, FAO, USAID).

It could appear surprising that the project did not make fuller use of the maps produced by the Ethiopian Mapping Agency (EMA). The EMA has detailed paper topographic maps available for much of the country; however their use was limited by a number of factors:

- only printed map sheets were available and digitizing them would have been difficult and expensive for the large areas involved;
- the maps have a date range of almost 30 years, which means that a lot of the infrastructure data (school locations in particular) have major gaps;
- no detailed borders of the administrative units are given; most maps pre-date the new borders anyway;
- to be of use, a high level of co-operation would have been needed between the MOE, EMA, CSA and regional bureaux and, as is true in most countries, this was not forthcoming.

If the other geo-data described earlier had not been available, then more use would have been made of the EMA map sheets. A common problem in many countries is co-ordination of and access to geo-data. A stated aim of the school mapping programme was to promote inter-agency co-operation in this area and this has resulted in mutually beneficial data-sharing taking place.

Two particular sets of data deserve more detailed attention: education statistics and school-location data, collected through Global Positioning Systems.

Educational data

On the whole, sufficient educational statistical data were available, although the quality of some data was poor. Ethiopian school-level educational data are collected via an annual school questionnaire, which is redesigned from time to time to reflect changes in the education system. It covers student enrolment by age and grade, repeaters, teachers, sections (pupils taught together as one 'class'), school infrastructure and finance. Data collection at school level is performed by people of different educational qualification varying from simple clerks to headteachers. The record keeping at the school level suffers from organizational defects, unqualified manpower, inadequate materials and facilities, and procedural weaknesses. Organizationally, there is no unit for record keeping. In some schools, the director or the assistant takes care of the record keeping and completing of the school questionnaire. In others, there are assigned clerks. No pre- or in-service training is provided. Inadequate materials and logistics affect the process of data collection, and paper forms to be used have not always been systematized. Data aggregation is carried out manually at the *wereda*, zonal and regional levels as a way of providing regional and sub-regional information needed for planning.

In most of the regions, extensive regional and sub-regional reports have been prepared using computers. In these regions the school questionnaires are entered by data entry clerks, supervised by Regional Education Bureaux (REB) planning staff. The school questionnaire is designed to be entered through the EMIS EdDat system. The EdDat system, a combination of a Microsoft Access

database and Visual Basic data entry forms and reports, was developed by EMIS staff in order to facilitate entering school-level data and to produce the desired reports at school, *wereda*, zone and regional level. Lack of computer skills/training, high staff turnover and low salary lead to a situation whereby accuracy of data entering is threatened. Other regions have produced simpler reports manually, or do no report at all; the pastoral regions have yet to supply the MOE with a list of their schools' names. In some cases, recently acquired computers are kept in the storeroom, as no trained personnel exist to use them.

After completion of data collection, computerized regions send their data through diskettes while other regions send the questionnaires to be entered at the MOE EMIS. Data encoders carry out editing activities to check and verify the data in preparation for proper utilization. Finally, national descriptive statistical reports, based upon the needs of users, are produced annually and disseminated to interested organizations. Despite problems already raised, the education information system in Ethiopia provides reliable school-level information for over 90 per cent of the country and is superior to parallel systems in others sectors such as health.

Global Positioning System (GPS) data collection

As mentioned earlier in this chapter, exact school positions could not easily be estimated from existing paper maps. This factor, together with the relatively inexpensive GPS machines now available, led to the decision to undertake a baseline survey to identify the locations of all the schools in each region covered by the programme. At the moment of writing, about half of the schools of Ethiopia were covered by this method.

This data collection campaign followed a methodology by which the region nominated people from all over their region to attend a

two-day training session and then embark on the GPS collection of the school locations. Typically a person would be assigned three *weredas* (normally around 100 schools) that covered his home area and would be given two to three months to collect the information, travelling by local transport, on mule or on foot. The people nominated for this task varied between regions; high-school graduates, teachers, *wereda* and zonal education officials have all been used, with a member of the regional bureau acting as co-ordinator and training assistant. Despite low exposure to technical equipment, around 90 per cent of the trainees were able to complete the work unsupervised after the two-day training course. Data-entry sheets listing the schools to cover were prepared, using the EMIS school-level database. A unique code assigned to each school was used to store the co-ordinates in the GPS's memory, which allowed to cross-check with the paper records kept. A section of a sample data-entry form is displayed below. In order not to duplicate data collected via EMIS, only information relating to the school location and the condition of buildings was collected.

Amaro Sp. *Zone / Spec.* **Amaro Wereda**
Wereda

ID	School (level)	Village	Grade	U/R	Func? Y/N	Lat / North Deg.	Minutes	Long / East Deg.	Minutes	Date	EPE (m)	2D/3	Alt. (m)
1635	Keli (A)	Keli		U									

Condition: A B C D E | Details:

PA\Kebele Id: | PA\ Town name: | New Wereda:

Most of the data collectors were salaried staff, but to give an incentive and to cover travelling costs, a payment was made on the basis of the number of schools covered. In the Amhara region the payment per school was set at about US$4; in other regions a daily rate was calculated and transport receipts refunded. Negotiating agreement with the collectors on payments and allowing for differences in terrain and climate were perhaps the most difficult

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aspects of the process. A strong expectation of additional payments for donor-supported work has developed in Ethiopia over the years. Given the low pay levels for government workers, this is perhaps not surprising; a newly qualified teacher starts work on a salary of around US$50 a month.

To make the campaign more cost-effective, the positions of the health facilities were also collected along with the schools. The cost and effort associated with doing this was minimal as schools outnumber the health facilities and most are situated close together in towns or major villages. Health-facility locations are useful to know in deciding where to upgrade existing schools; the data were also passed on to organizations active within the health sector. All of the collected information on paper was cross-checked against the GPS memory on arrival and then entered into a customized Access database by the REB data-entry clerks. Some difficulties again arose due to inexperienced users, lack of an effective REB co-ordinator in some regions and unrealistic payment expectations.

Data checking, integration, storage and updating

An important aspect to remember when considering the operations of a GIS is that its usefulness depends on an accurate, well-designed and documented database. Most of the time-consuming work in setting up the GIS goes into database preparation, with the map production being relatively quick and interesting in comparison.

To verify the accuracy of the GPS data the school locations were displayed on the map and a spatial query run by the GIS to identify schools that did not lie within the boundary of the *wereda* to which they were reported to belong to. Schools that matched this criterion were cross-checked back to the paper records or GPS memory and corrected if necessary. In cases where schools were just across the

wereda boundary, it suggested errors in the administrative geo-layers, not the school positions. No single geographic layer should be considered 100 per cent correct, account should be taken of its source and likely level of accuracy. Visual inspection may also identify possible errors or can help verify positions when the school locations are compared to geographic features. Inevitably some minor errors escape this process; the GPS should give a reading accurate to within 50 metres on the ground. After preparation of printed maps local officials were asked to report potential errors in school positions. In some cases school co-ordinates were re-taken via GPS or estimated using other data sources. Corrections via GIS to other geo-layers were applied to create consistent maps; this was a major task for roads as no accurate road map could be found in Ethiopia. If necessary, road locations can be taken by driving a car equipped with GPS down the road and downloading the generated data into the GIS.

The two major tasks related to the integration of data were:

- to link school locations, collected via the GPS, to statistical variables, collected via EMIS; and
- to link administrative units to population variables, obtained through the census.

Both tasks required the use of a consistent coding mechanism for schools and administration units, combined with a thorough understanding of a relational database (in this case Microsoft Access). A set of database queries known as *EMISLINK* was developed to aggregate statistics such as total enrolment by grade or number of teachers from the standard EMIS database, which stores data at a disaggregated level (number of Grade 1, age seven male pupils, etc.) which is more difficult to analyze directly. The newly developed database was then used to generate queries that linked information and stored the results in a single large school-level data table that

includes the school's name, code, location, facilities, condition and all the education statistics collected via EdDat. A consistent school coding system was particularly important and the existing coding system had to be modified to allow for the combination of enrolment statistics from different years (1987-1988-1989 E.C.). this allows the generation of variables indicating changes in school enrolment over time, which is an important indicator in considering school upgrade priorities. For the population statistics, similar database queries were used to calculate population variables such as school-age population, project them from the census of 1994 to the present day and then to link these variables to the *weredas* and Peasant Association geo-layers. Finally the integrated school and population data files were imported into the GIS format (MapInfo in this case) and opened in combination with the other geo-layers collected. These data were then utilized for on-screen analysis and the preparation of printed maps by the methods discussed in *Chapter 2*.

As well as requiring experience in the use and manipulation of data via relational databases and GIS software, a good working knowledge of data management techniques is required to store the large and numerous data files created. Each geo-layer consists of four or five different data files that need to be stored together; a set of map 'definitions' is stored in an additional controlling file which makes reference to many subservient geo-layer data files. Without a rigorous, well-understood data storage structure, changes to files may cause unforeseen consequences such as display maps that can no longer locate subservient files. *Table 2* below gives an indication of the different geo-layers used; it was drawn up whilst documenting the GIS developed for the region of Tigrai.

Table 2. Different geo-layers used

File name (Location)	Geographic Type	Description
\TIG		
HYDRPNP.TAB	Point	Water points (wells, springs)
HYNETLL.TAB	Line	Elevation contours (1,000 feet intervals)
RDCC.TAB	Point	Rural day care centres (Degua Temben *wereda* only)
REST_WPT.TAB	Point	Water points collected by REST
TEKRIVER.TAB	Line	Rivers (all of Tekezze River Basin)
TIGPOWER.TAB	Line	Electric lines (schematic)
TIG_CATS.TAB	Region	Primary school catchment areas
TIG_ENUM.TAB	Region	Enumeration areas (PAs and urban towns) linked to population
TIG_HLTH.TAB	Point	Health facilities
TIG_REG.TAB	Region	Region outline
TIG_ROAD.TAB	Line	Roads (dry or all-weather classification)
TIG_SCL.TAB	Point	Schools and their statistical attributes from EMIS
TIG_WEB.TAB	Point	*Wereda* education bureaux
TIG_WER.TAB	Region	*Weredas* with census population attributes
TIG_ZONE.TAB	Region	Zones
TIG_PS5K.TAB	Region	Areas within 5 km of school (primary), split by *wereda*
TIG_SETT.TAB	Point	Village/settlement points (no data) from census maps
TIG_REGL.TAB	Point	Churches and mosques (no data) from census maps
TIG_GM_M.TAB	Point	Grinding mills and markets (no data) from census maps
\DEM		(All DEMs 240 metre elevation interval by colour)
ELEV_LEG.TAB		Display of DEM colour for map legend
TEKELL20.TAB	Raster	East Tekezze Basin DEM, 50 metre pixel, lat/long projection
TEK_WD20.TAB	Raster	West Tekezze Basin DEM, 50 metre pixel, lat/long projection

Each GIS software has a different internal file format and these are usually inter-convertible via import/export facilities. To utilize geo-data coming from diverse sources demands an understanding of conversion techniques and a common file format in which to store incoming data. Moving data between computers or creating backups requires the use of mass storage devices or networks as the associated files are usually too large to transfer via floppy disks. External high-capacity disk drives, that can move up to 100MB of data on a single disk, have proved highly useful in Ethiopia, especially for transferring data between the regional offices and the MOE.

To update the GIS inevitably requires a good understanding of the method used to collect and integrate the data and a thorough documentation system that describes the procedure. A small number of GPS machines were left at the REBs on completion of the baseline survey to allow for periodic updates of the positions of newly built schools. These records may be added on to the end of the school geo-data file, simply to display their positions. An annual update of the school attributes using the database integration technique described above is necessary to reflect the new statistics collected via the annual school questionnaire. The EMIS system is well established and the school-level data are annually updated as a matter of course. Under the decentralization policy in Ethiopia, the overall responsibility for collecting and updating school-level data rests firmly with the regions.

New geo-layers or corrections to existing ones may easily be introduced to the system, although care should be taken that these do not affect files prepared for map printout. It is obviously much easier keeping the data files on the computer up to date as opposed to printed maps, but printouts are needed for wider dissemination and use of the school mapping information.

CHAPTER 4
SETTING UP A GIS ON EDUCATION: A CAPACITY-BUILDING EXERCISE

SETTING UP A GIS ON EDUCATION: A CAPACITY-BUILDING EXERCISE

An external consultant, one of the co-authors of this paper, was asked to establish the school mapping activities in Ethiopia. The MOE prefers to use internal capacity to implement programmes, but realized it lacked the necessary skills and experience in this relatively new discipline. The tasks required to plan and technically set up the GIS have already been described; the other major objective of the work was to build capacity within the education system to make the programme sustainable without major external assistance in the future.

Training

To implement the school mapping programme, the availability of skilled manpower both at central and regional levels is indispensable. To achieve this goal four different types of training were planned to try and effectively deliver the necessary skills.

1. Informal, *ad hoc* training involving one-on-one computing work with the external consultant during the various stages of data collection, integration and GIS use. This was one of the most effective methods for technical counterparts assigned from the MOE and REB planning departments and involved solving technical problems as they were encountered in the day-to-day work. GIS is a multi-disciplinary area that requires the ability to search for practical solutions with a degree of flexibility.

2. A general introductory six-day training programme was given to technical staff from the MOE and regions at the conception of the school mapping activities to raise awareness of the programme and its potential. After 10 months, when the programme's plan and

direction had been much more firmly defined, a revised version of the course was delivered in collaboration between the PHRD (Policy and Human Resource Development) project office, the IIEP (International Institute for Educational Planning) and the BESO (Basic Education System Overhaul) project. The purpose of the training was to:

- introduce the concepts of education mapping and its use in planning;
- give practical computer-based training in the use of a database, GIS and GPS.

The course was delivered by the external consultant, with the MOE school mapping counterpart providing support. Two participants, an educational planner and statistician, from each region attended this computer-based training course, which introduced the following skills and activities:

- background theory of database and GIS;
- use of Windows 95 operating system, file and directory management;
- use of GPS to find co-ordinates;
- MapInfo GIS tutorial;
- geo-referenced data entry and co-ordinate conversion;
- use of Access to extract data from the EdDat system;
- import and export of data between spreadsheet and database software;
- creation of point data maps, altering the map layout;
- adding themes to point data maps;
- linking of database attribute data to maps;
- cross-referencing data tables to match indexes and link data tables;
- creation of thematic maps.

The following week, closely-related training was given by the IIEP to build the trainees' skills in the application of school mapping to education micro-planning. The participants found the course to be useful but stressed the need for follow-up training. One significant problem apparent during the training was the lack of basic computer skills of about half of the participants. It is intended to deliver relevant sections of this course again to members of the MOE's planning department in the near future.

3. To collect the school co-ordinates, a two-day basic training course in the use of GPS was given in the following towns: Mekele, Axum, Awassa, Arba Minch, Bahir Dar, Dessie, and Assosa. The primary objective of this training was to enable the data collectors to be able to complete their task, however it was also an opportunity to train the REB co-ordinator to give the course in future. Demonstrations of the GIS were given to promote the programme to bureau officials in the towns visited.

4. The final area of training planned was to show planners and decision-makers how the GIS may be utilized effectively in the planning process. This was aimed to cover both the interpretation of paper maps and simple use of the GIS to analyze the collected data on the computer via the method described in *Chapter 2.2*. By its nature this type of training cannot be given until the majority of the GIS system has been formed. To date, training of this nature has not been given in Ethiopia. This is perhaps due to lack of computer skills amongst senior officials (most make extensive use of secretaries for word processing), coupled with a reluctance to involve external staff in a sensitive decision-making process.

The training conducted to date in Ethiopia has been successful in introducing a new field of work into the education system and generating a keenness to utilize it. Technical staff now exist within

the MOE and some of the regions who could organize and run the GPS data collection and utilize the GIS to create simple thematic and school-level micro-planning maps. More advanced skills would develop in time, given the opportunity to work with the GIS on a regular basis and receive some further advanced training. The major problems envisaged would be getting the GIS properly utilized by decision-makers/planners and retaining trained staff within the lowly paid government education system.

Institutional capacity building

The federal system of government the country adopted has given the responsibility for decision-making on most regional issues to the regional councils. Most educational functions that used to be carried out at the Ministry of Education are now the responsibility of the regional education bureau (REB). As part of the decentralization reform, the Ministry of Education has not dramatically downscaled, but reorganized and roles have been redefined. The role of the Ministry of Education, in relation to the regional and sub-regional units, has changed from one of control to providing support services to the lower units. One part of this support related to statistics and planning comes under the Planning and Project Department (PPD).

PPD contains two panels (subunits) that are now involved with the GIS activities: the Educational Management Information System (EMIS) panel and the Planning and Programming panel. EMIS is designed to serve educational planners, managers and inspectors through the provision of educational information. As the EMIS panel was already well equipped, in terms of a functional computerized system and experienced staff, it was the natural place to co-ordinate school mapping activities. Regional school-level data are stored on the EMIS network and an indexing system is being developed to link this information with the existing EdDat system. School mapping tasks

assigned to the EMIS panel include the national integration of school-level data, providing a technical support service to the regions (GPS, basic GIS and database training) and the preparation of thematic maps to illustrate national-level disparities in education provision. The Planning and Programming panel intends to use the national-level GIS to assist in the formulation and analysis of national education policy.

Within the four REBs worked with to date the responsibility for school mapping activities has been assigned to their planning departments. A counterpart, usually the statistician, was assigned to provide regional co-ordination of the data collection and to receive GIS training. Thus the REB planning departments are assigned to manage the collection and entry of school-level data in the baseline campaign and to regularly update the GIS with the location of new or potential school sites. They also have the responsibility to prepare detailed micro-planning maps and thematic maps highlighting *wereda* and zonal-level disparities.

At both national and regional levels these departments and panels have been strengthened to accommodate these extra tasks by the provision of equipment and technical training. The baseline data collection of schools' co-ordinates required a large, once-only effort by the regions involved. The donor agencies funding the programme provided assistance for this work in terms of communications, transport, administration and data entry. However no new government staff have been employed to carry out the long-term elements of the work.

In terms of sustainable capacity building, the main danger to the programme is the high rate of staff turnover due to resignation and reassignment. Trained personnel often leave due to the low salary levels and the absence of career development schemes. For this

reason an attempt was made to train more than one person in each region in the use of GIS. Some of the smaller, less developed regions would not at present have the capacity to carry out the responsibilities designated to the regions for school mapping. Thus it is essential that a strong technical capacity is retained with the MOE to assist the regions in school mapping work and provide continuity through long-term, experienced staff and reliable data archiving.

CHAPTER 5
CONCLUSION

CONCLUSION

The school mapping programme in Ethiopia has now been accepted by the educational establishment as a worthwhile exercise, despite some resistance in the initial stages from some senior officials who feared that it might be too complex for a country with such an underdeveloped education sector. These reservations were overcome primarily when the first set of micro-level planning maps became available and decision-makers could easily see the potential benefits of the programme. There has been a great deal of enthusiasm from the regional bureaux and the donor community to carry out the programme, partly due to the immediate use which can be made of the information in the planning stages of the school construction element of the ESDP. It is anticipated that the regions of Gambella and Oromia will be covered over the course of next year. Then the programme will have covered over 90 per cent of the country, leaving only the urban and pastoral regions where the benefits would not be so large and the data collection much more difficult.

The programme is generally seen to be successful, with obvious useful outputs becoming available after only a few months. The total cost of the work is not high when one considers the large sums being spent on capital investment: the total budget for the programme in the Amhara region (total population 14 million with over 2,800 schools) has been around US$50,000, less than the cost of two new 'pick-up' vehicles. Sharing of resources between regions, use of existing computer equipment and assignment of employees for fieldwork helped to reduce costs to a minimum.

The major obstacles to implementing the programme have generally been bureaucratic rather than technical in nature. The modern computers, software and GPS machine used are relatively easy to operate and require little maintenance. Once the regions

decided to implement the programme, they were able to mobilize their staff to carry out the baseline collection of school locations. Gaining access to other useful geo-data did cause problems and delays, requiring high-level officials to intervene to transfer information between government institutions. The main danger to the continued use of GIS in the education sector relates to the issue of sustainability. The decentralization policy puts a lot of responsibility on the regions, which often do not have the human resources necessary to meet them. If skilled staff are not kept at the national level to co-ordinate activities and provide technical support services, the GIS would be in danger of falling into disuse. The other problem that has not been completely addressed is how to get decision-makers and planners at all levels to utilize the GIS, preferably through direct use of the computer. Further training and awareness for managerial staff is needed to maximize the usefulness of the information integrated together in the GIS.

The education mapping programme has delivered timely, valuable information for educational planning activities in Ethiopia in a cost-effective manner. It has promoted the use of new computerized technology amongst education officials and illustrated novel techniques by which the education system may be analyzed to enable better-informed decision-making. Politically sensitive decisions such as the locations of new schools may be justified by an empirical, non-biased method. The GIS may be exploited to improve education monitoring and to maximize access to education for the rural population. A side benefit of the programme is to collate and provide GIS data that may be utilized in other sectors of development such as health, food security and agriculture.

It is hoped that this paper amply demonstrates to developing countries that a modern, useful GIS system for education can be successfully established, if the will to do so exists.

ETHIOPIA: LIST OF MAPS

1. Primary (1-8) gross enrolment ratio by region (1996-1997)
2. Gender proportion of secondary students and teachers (1996-1997)
3. Tigrai education map
4. School infrastructure and elevation
5. School enrolment and gender ratio
6. School catchment area
7. Language and school distribution
8. Percentage of Tigrai population by Wereda living within 5 km of a primary school

PALESTINE: LIST OF FIGURES

1. Distribution of lower basic schools - by locality
2. Distribution of upper basic schools - by locality
3. Distribution of secondary schools - by locality
4. Distribution of localities with no schools
5. Qalqilia School District
6. City of Qalqilia (school locations)
7. Village of Falamia
8. Site Plans - Azoon schools

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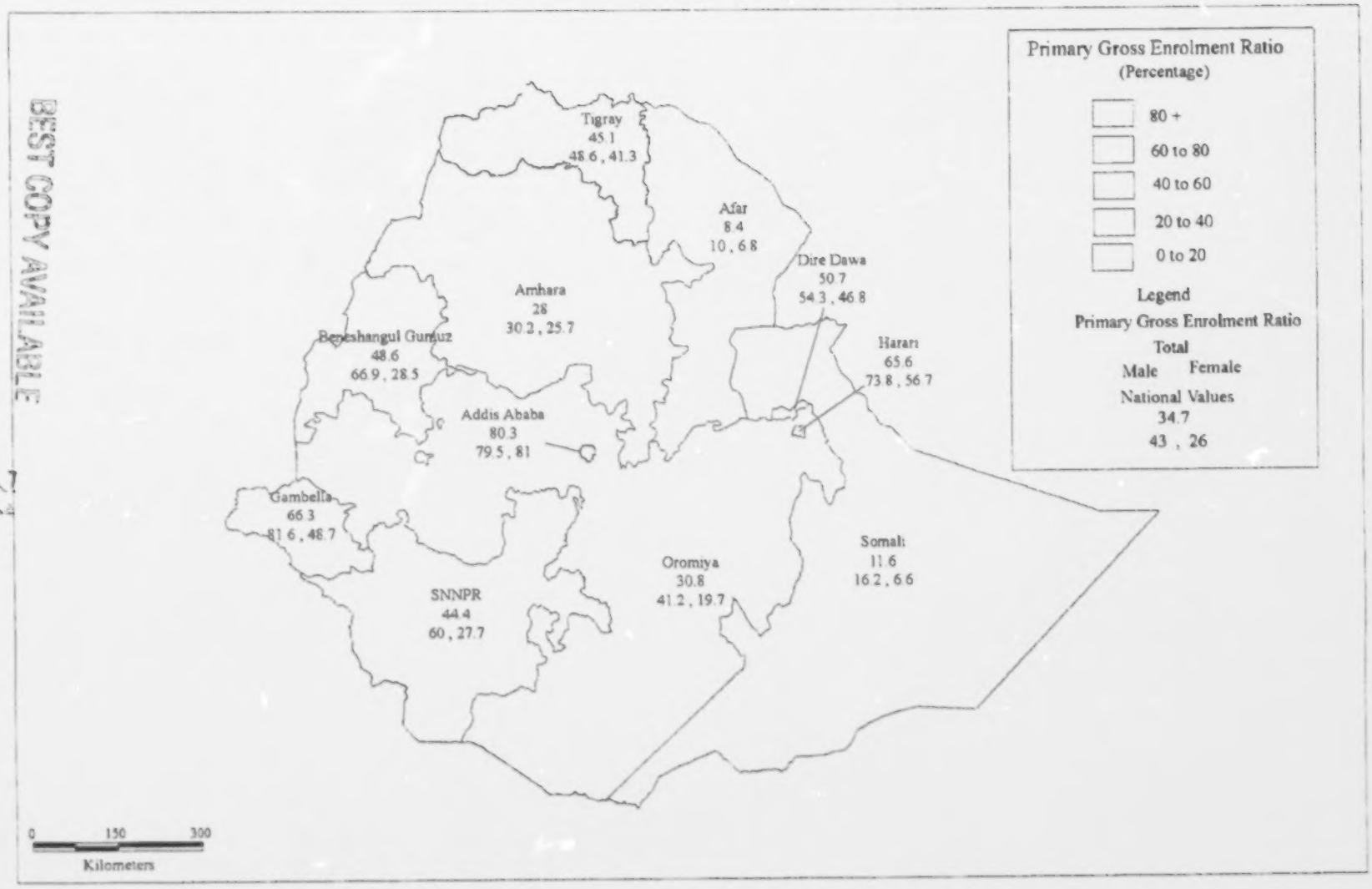
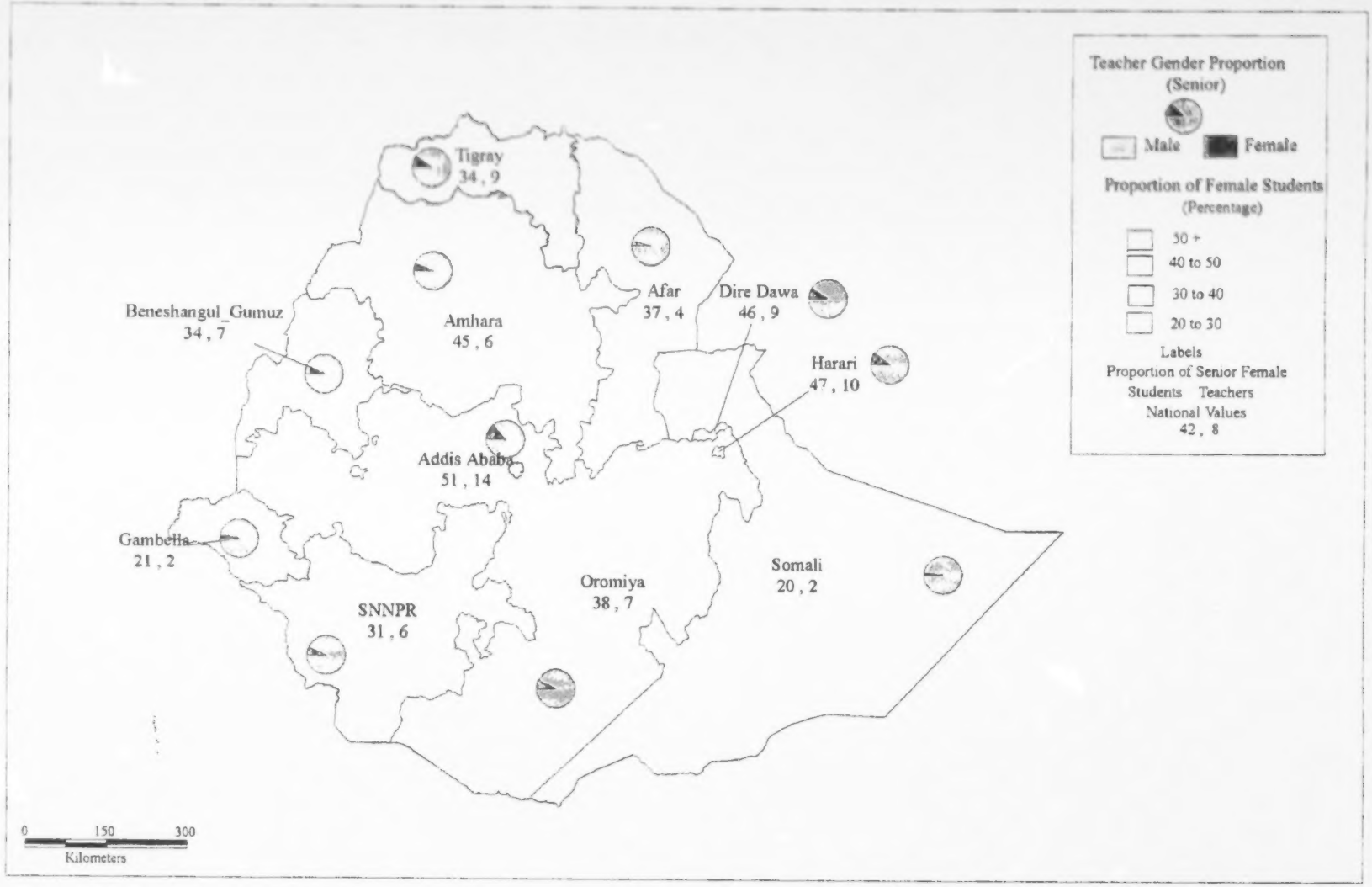


Thematic map 1: Primary (1-8) gross enrolment ratio by region (1996-1997)

Thematic map 2: Gender proportion of secondary students and teachers (1996-1997)



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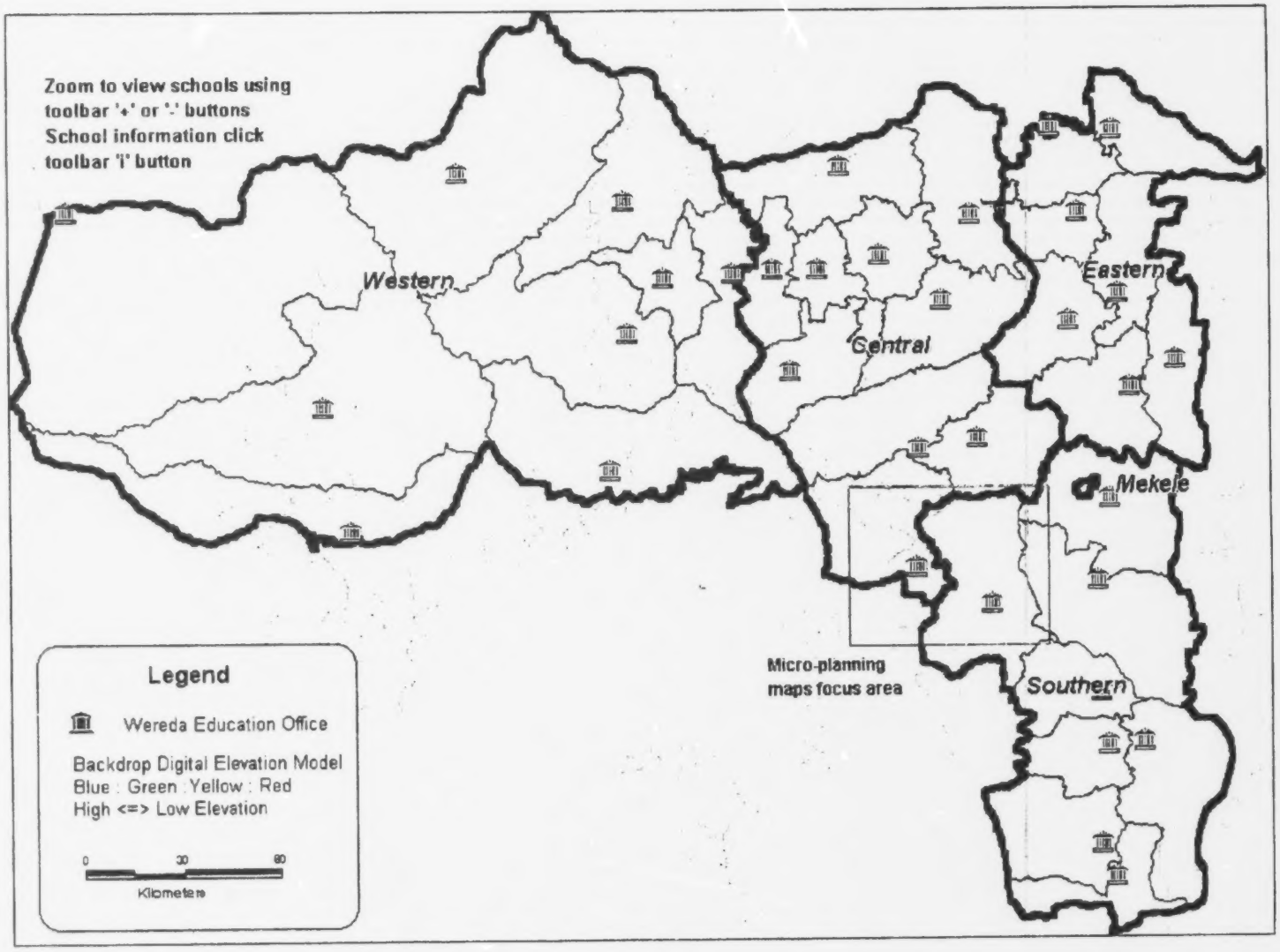

Map 3: Tigrai education map

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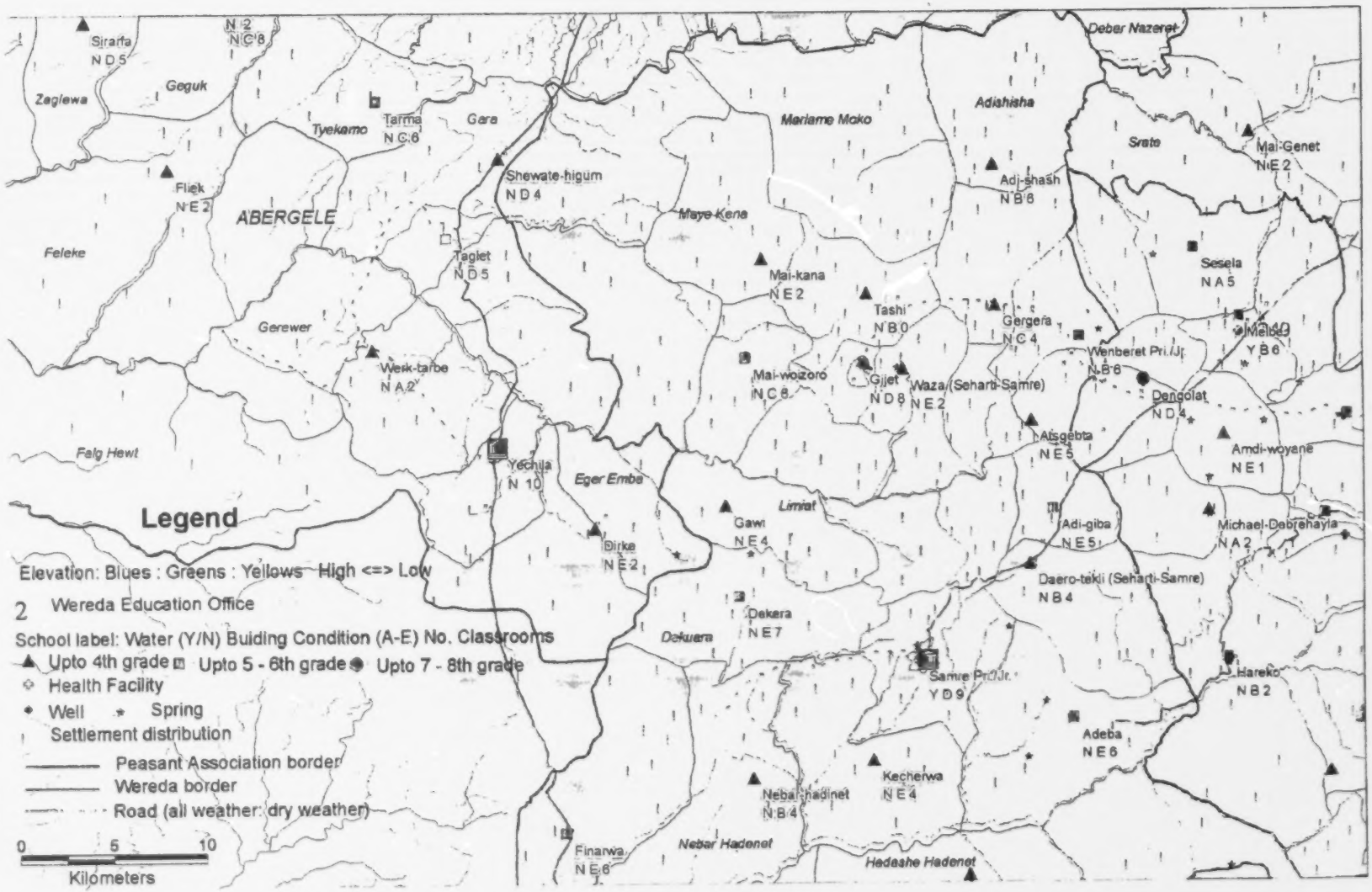
Map 4: School infrastructure and elevation



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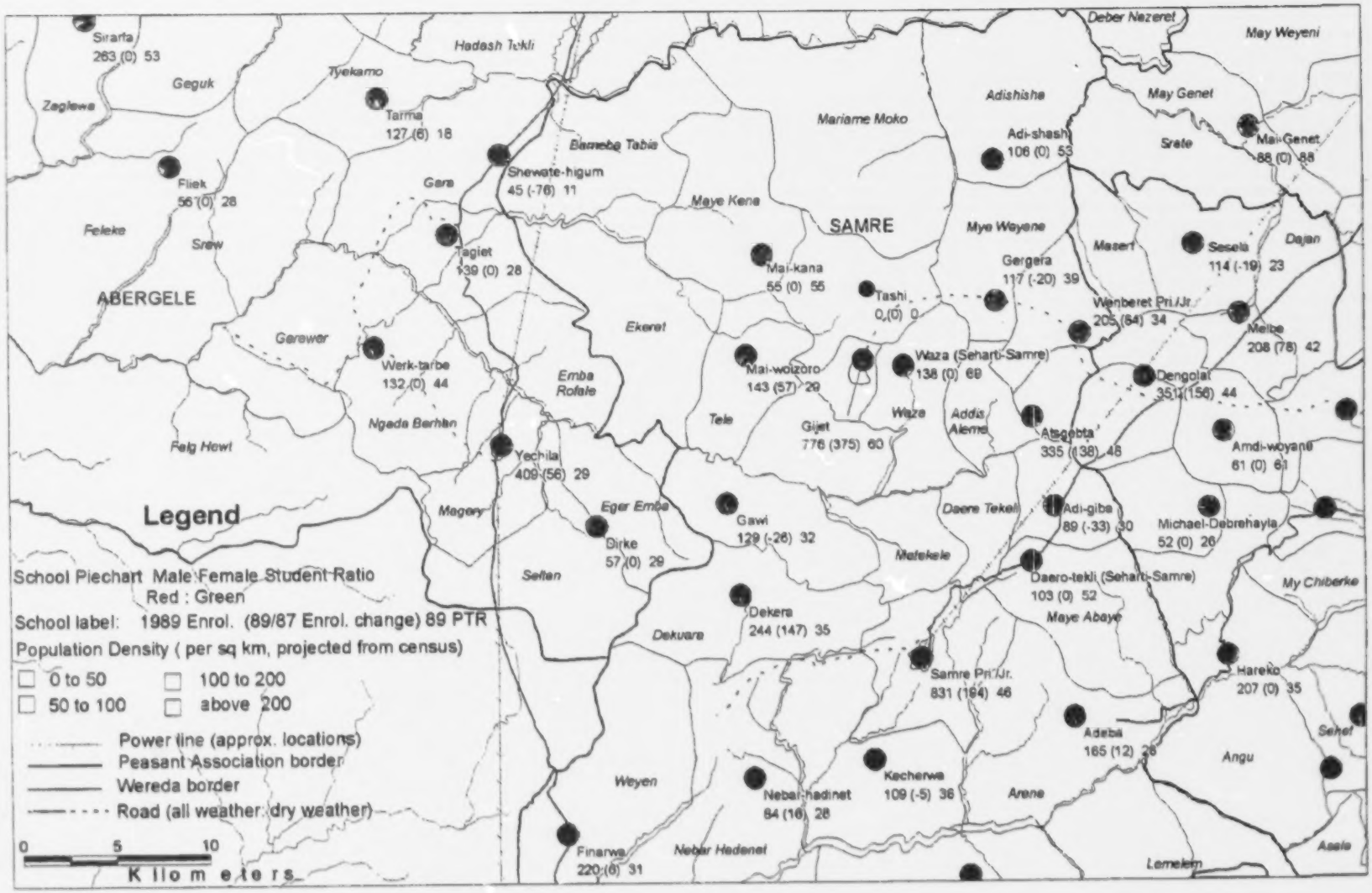

Map 5: School enrolment and gender ratio

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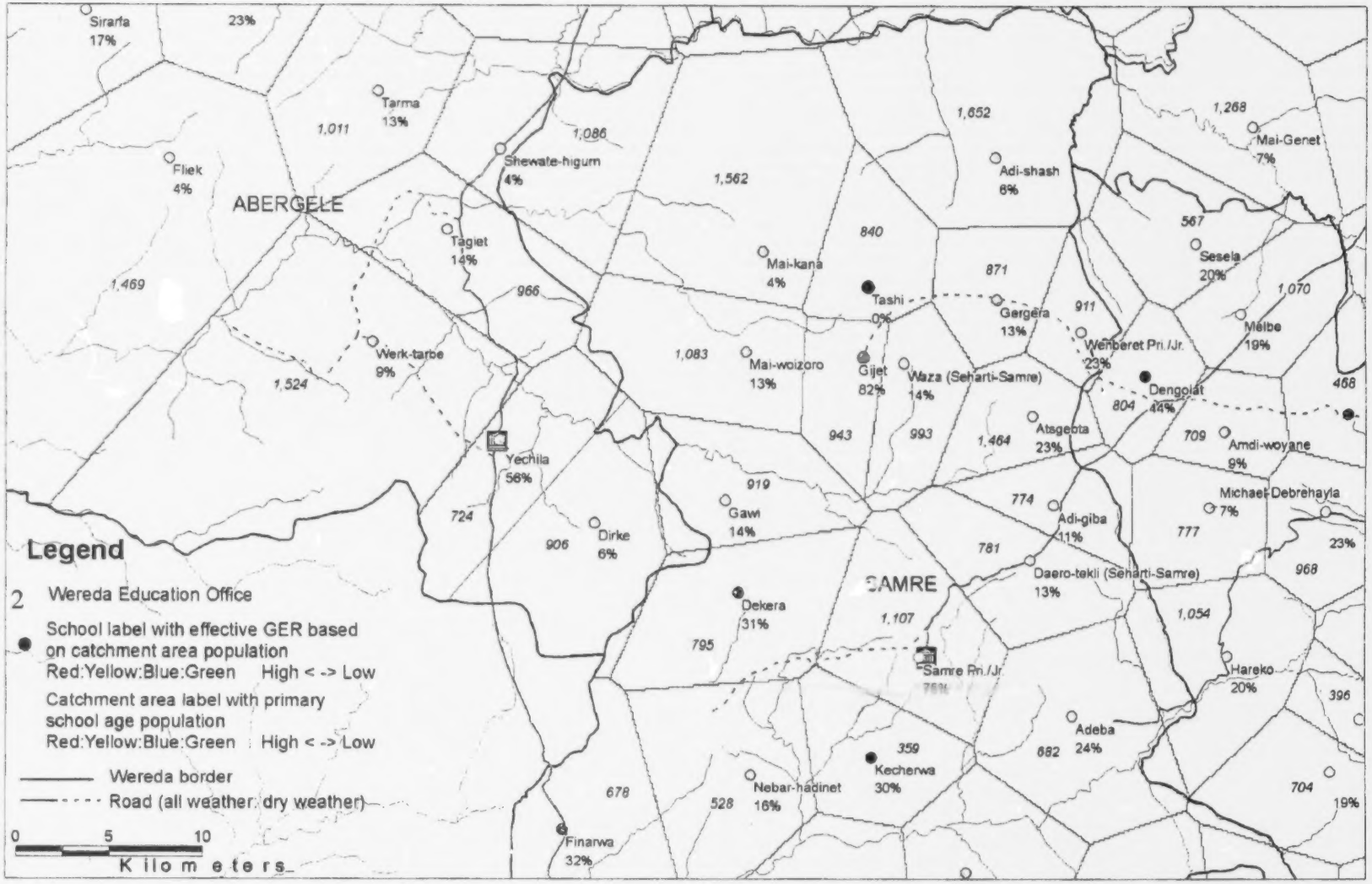
Map 6: School catchment area



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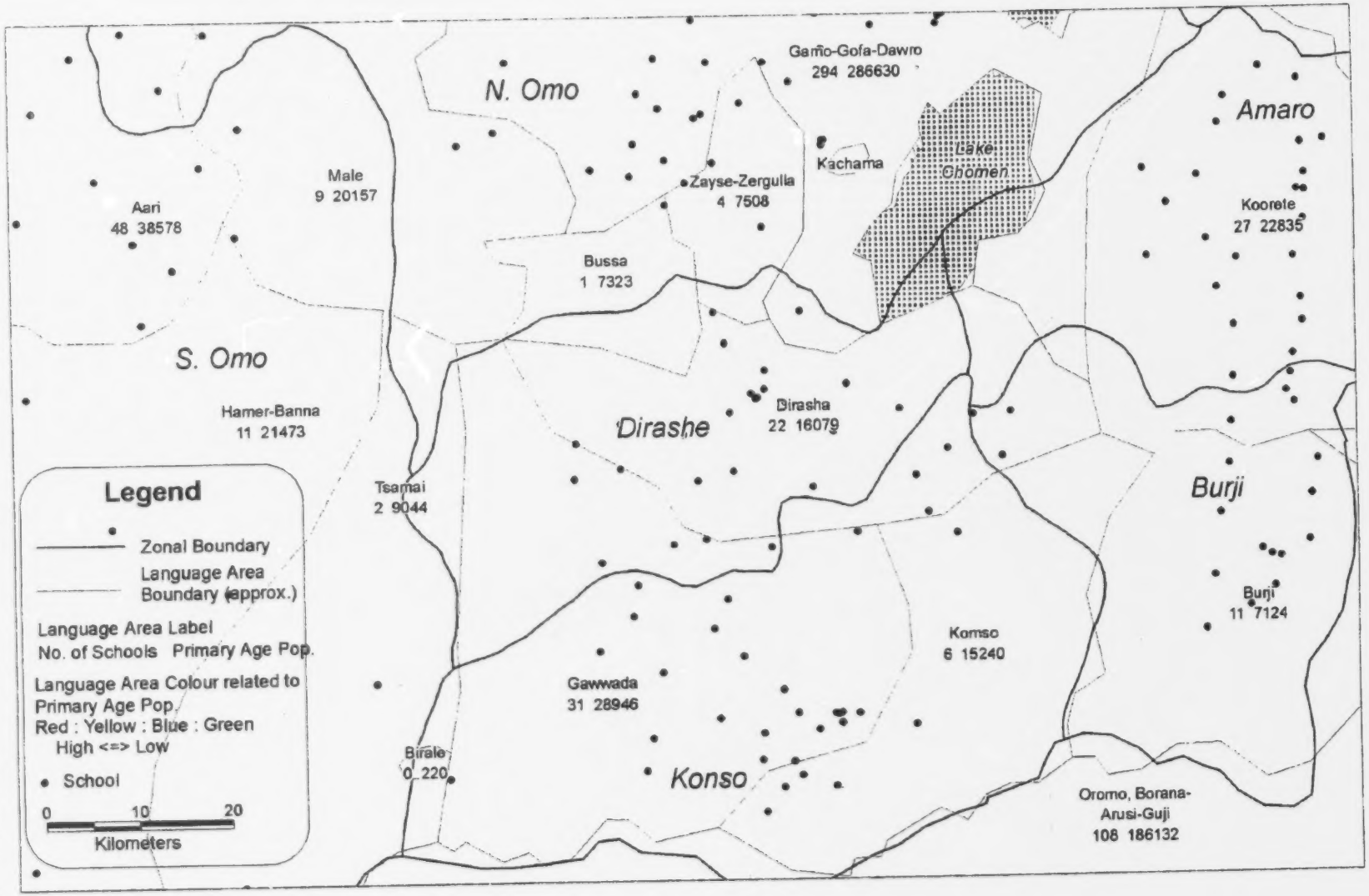

Map 7: Language and school distribution

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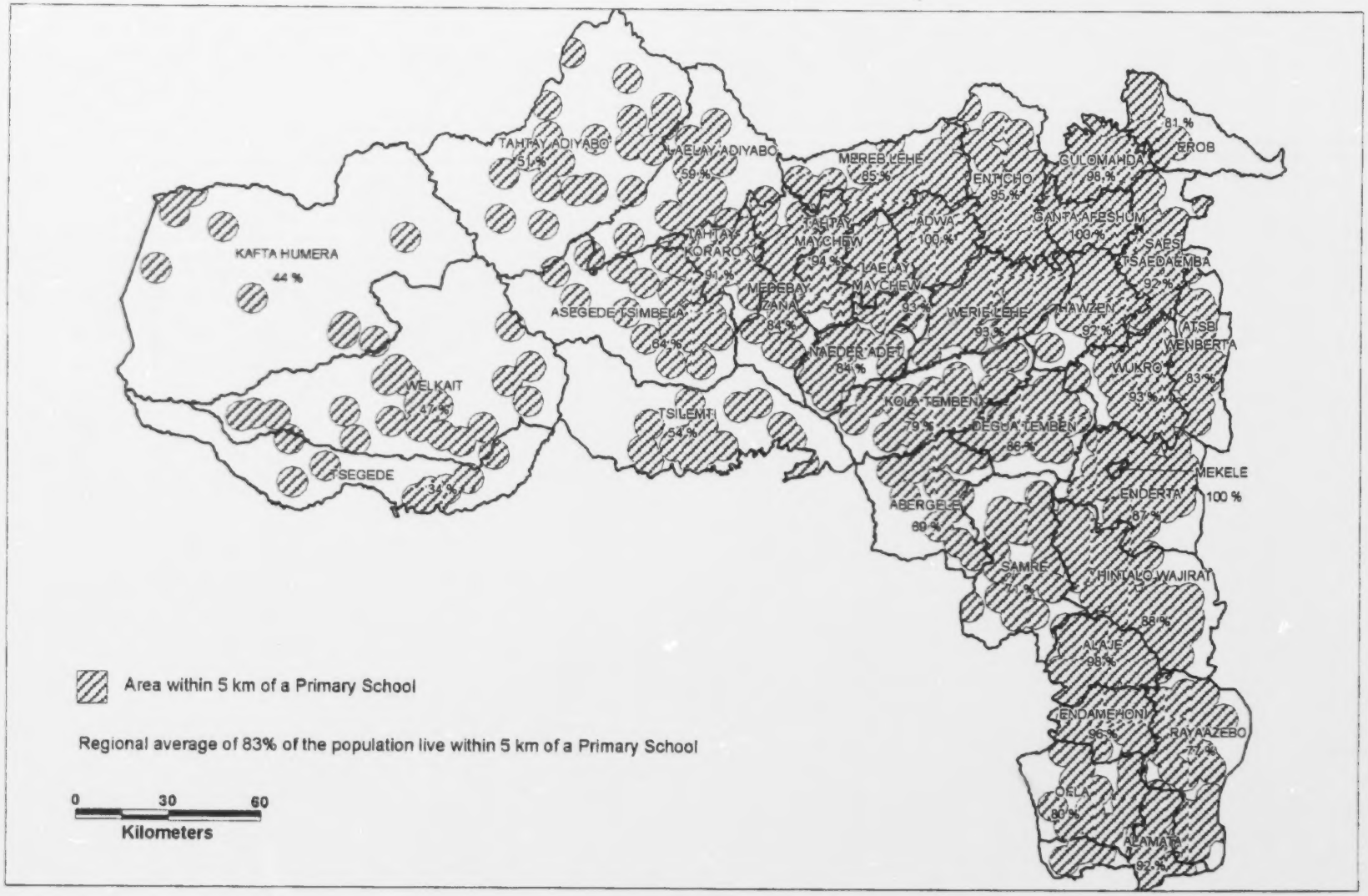
Map 8: Percentage of Tigrai population by Wereda living within 5 km of a primary school



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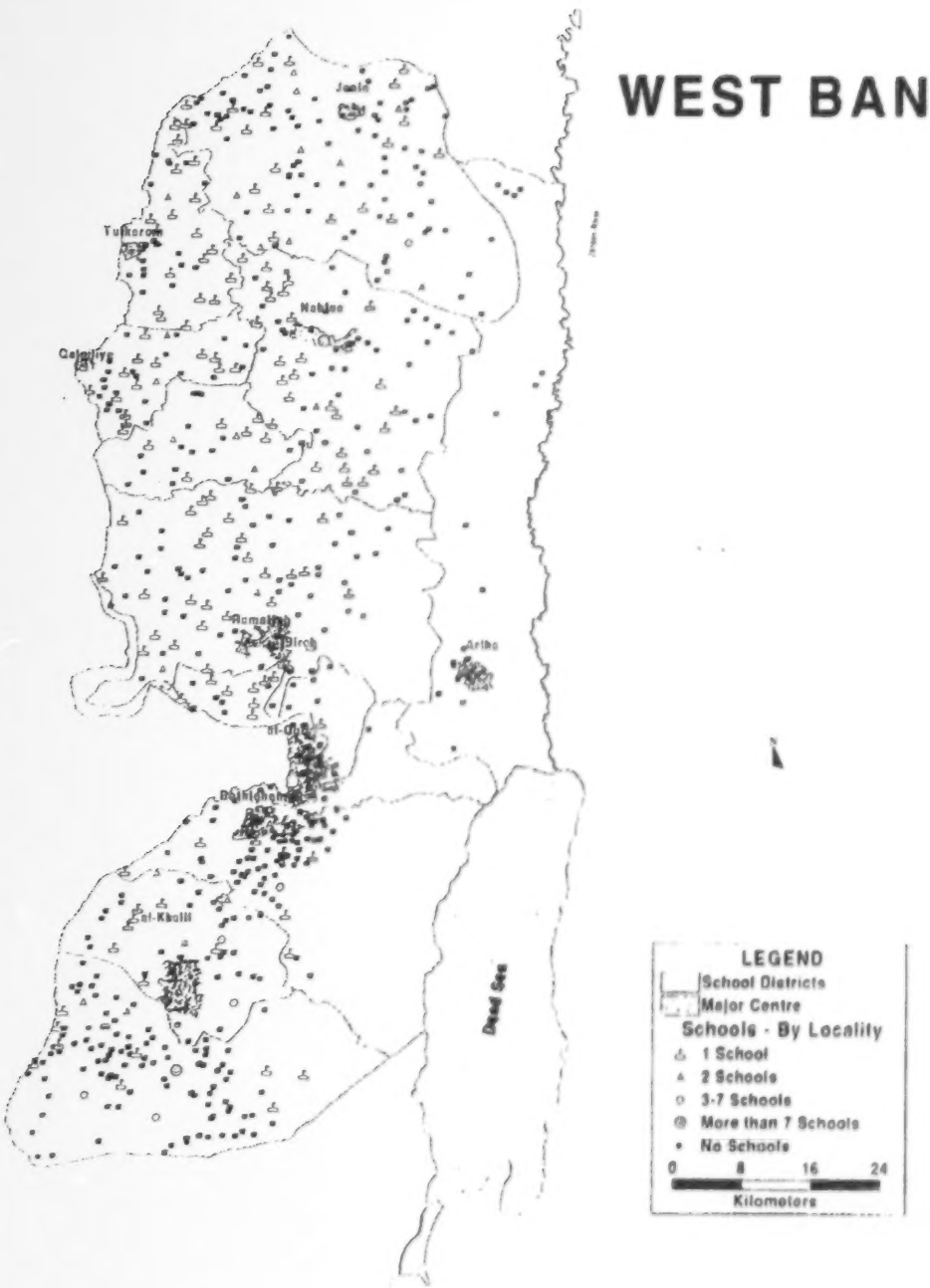

Figure 1: Distribution of lower basic schools – by locality

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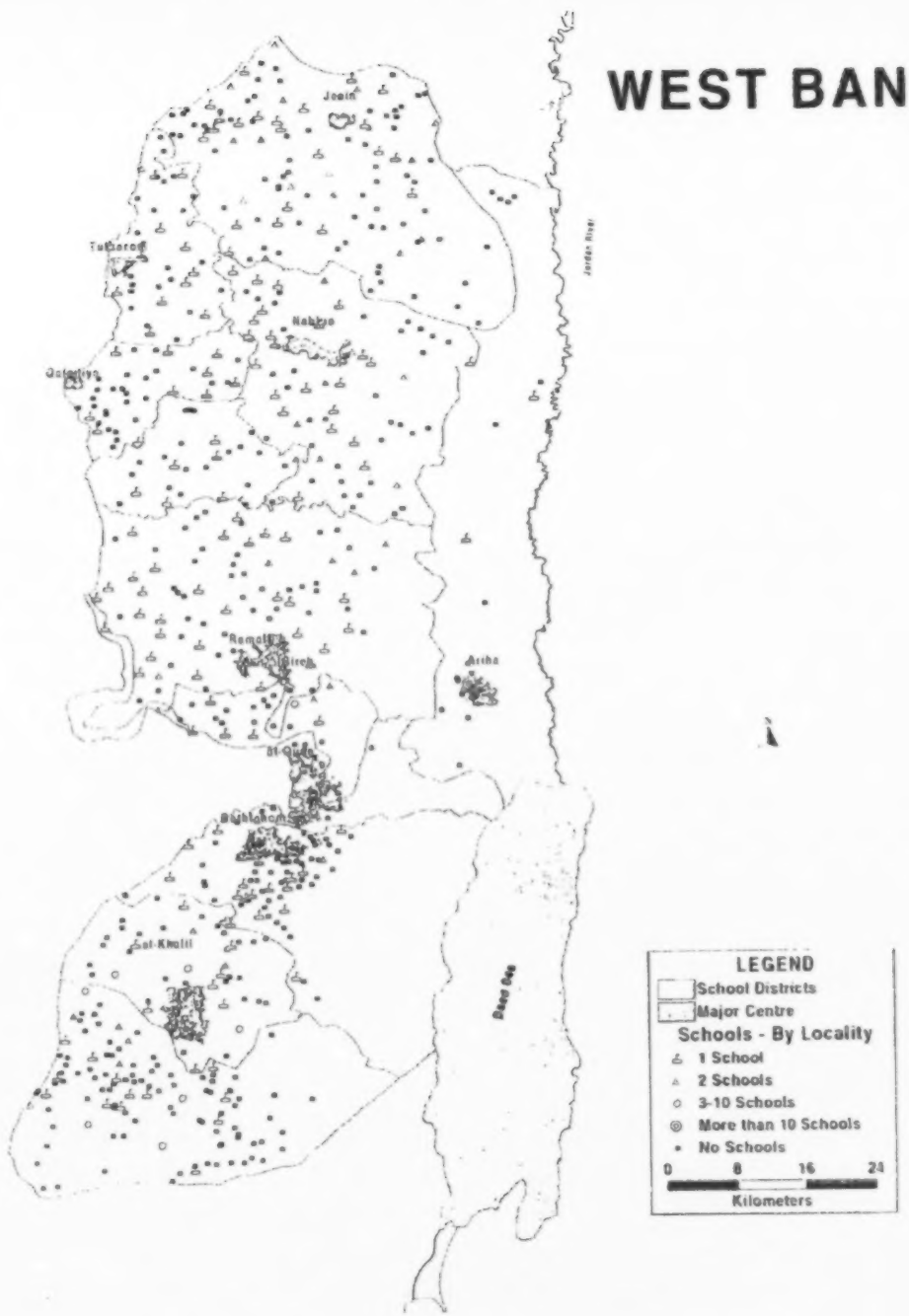
Figure 2: Distribution of upper basic schools – by locality



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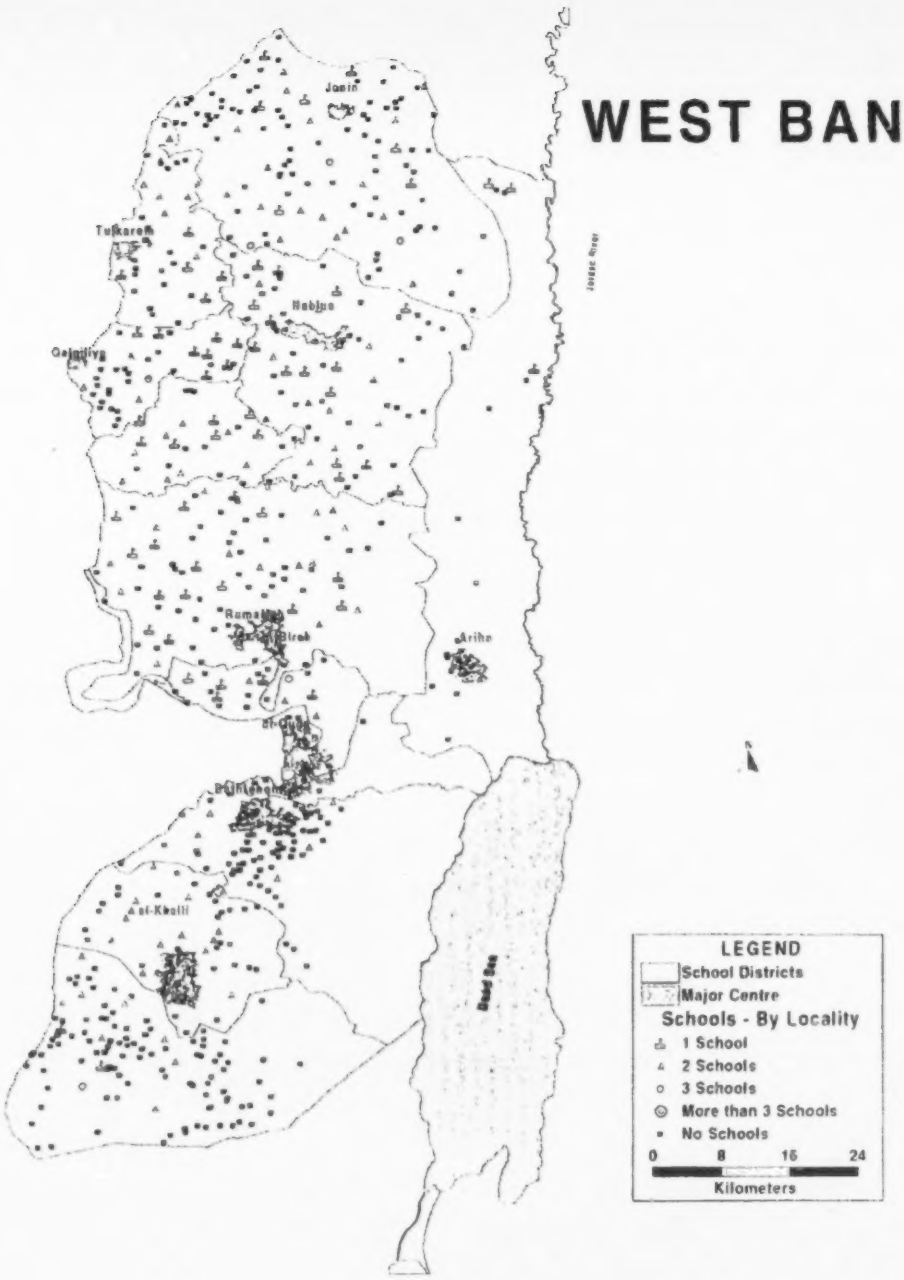

Figure 3: Distribution of secondary schools – by locality

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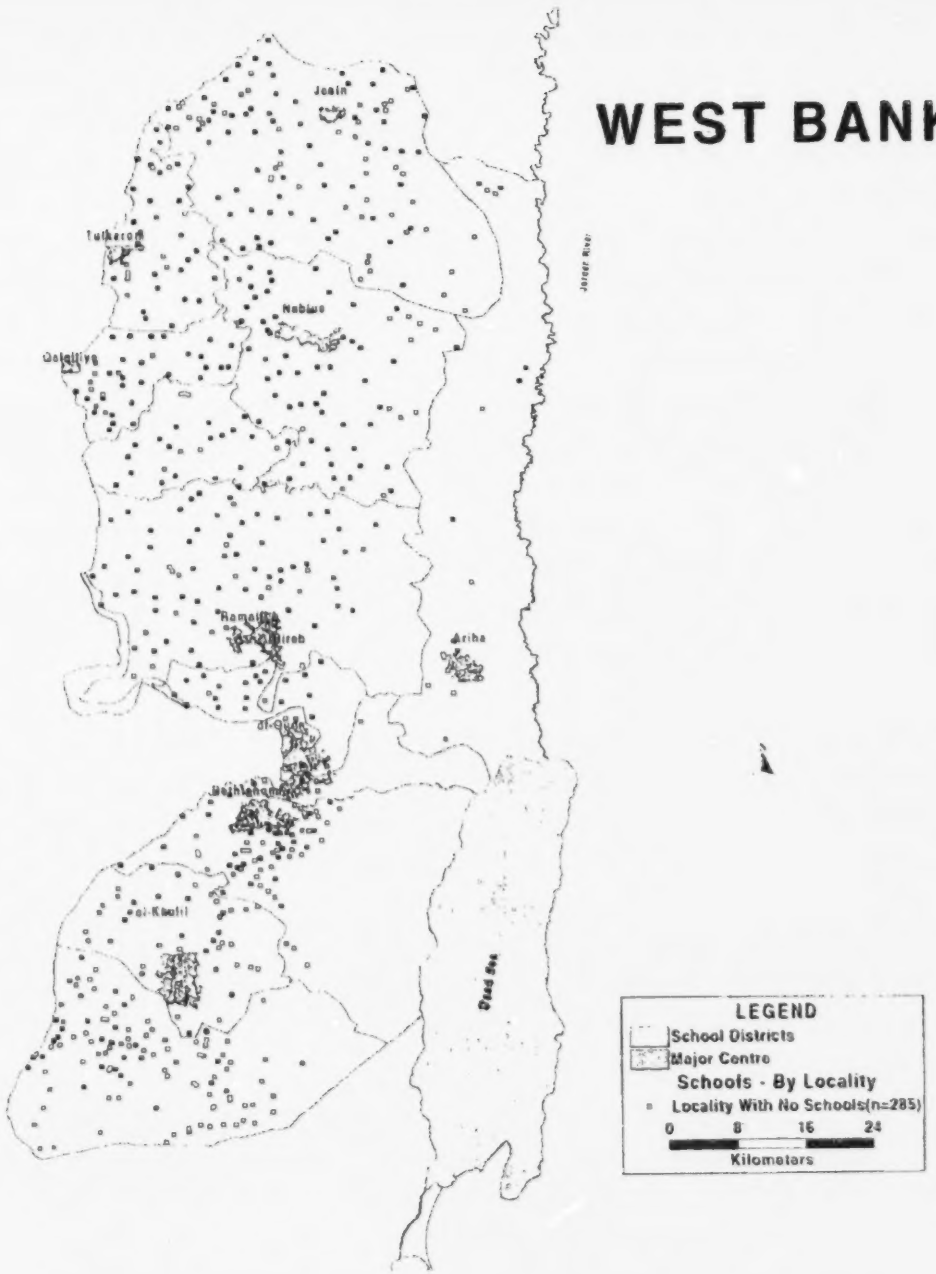
Figure 4: Distribution of localities with no schools



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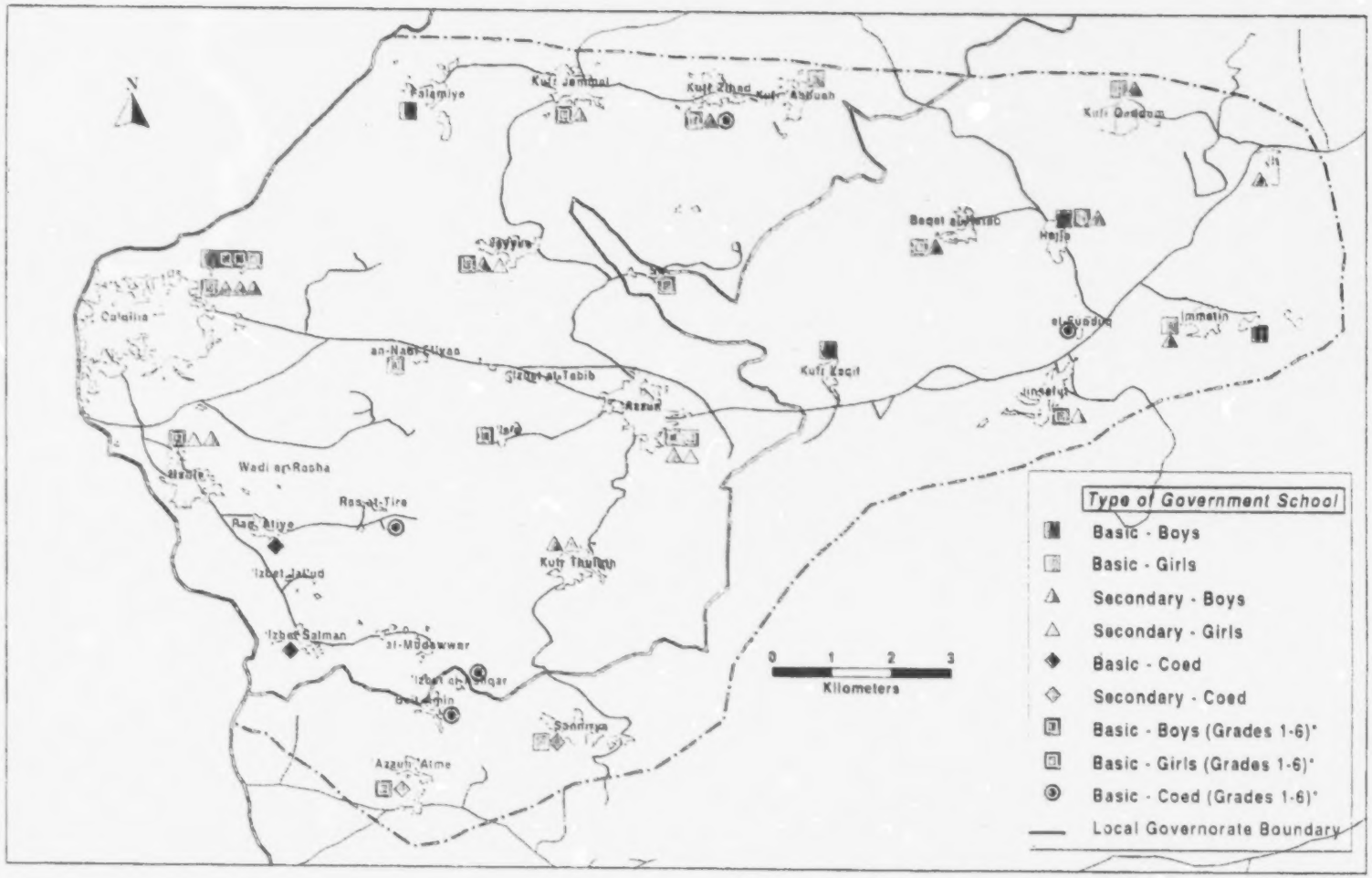

* Basic schools where the highest grade is less than or equal to Grade 6

Figure 5: Qalqilia School District

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Figure 6: City of Qalqilia (school locations)

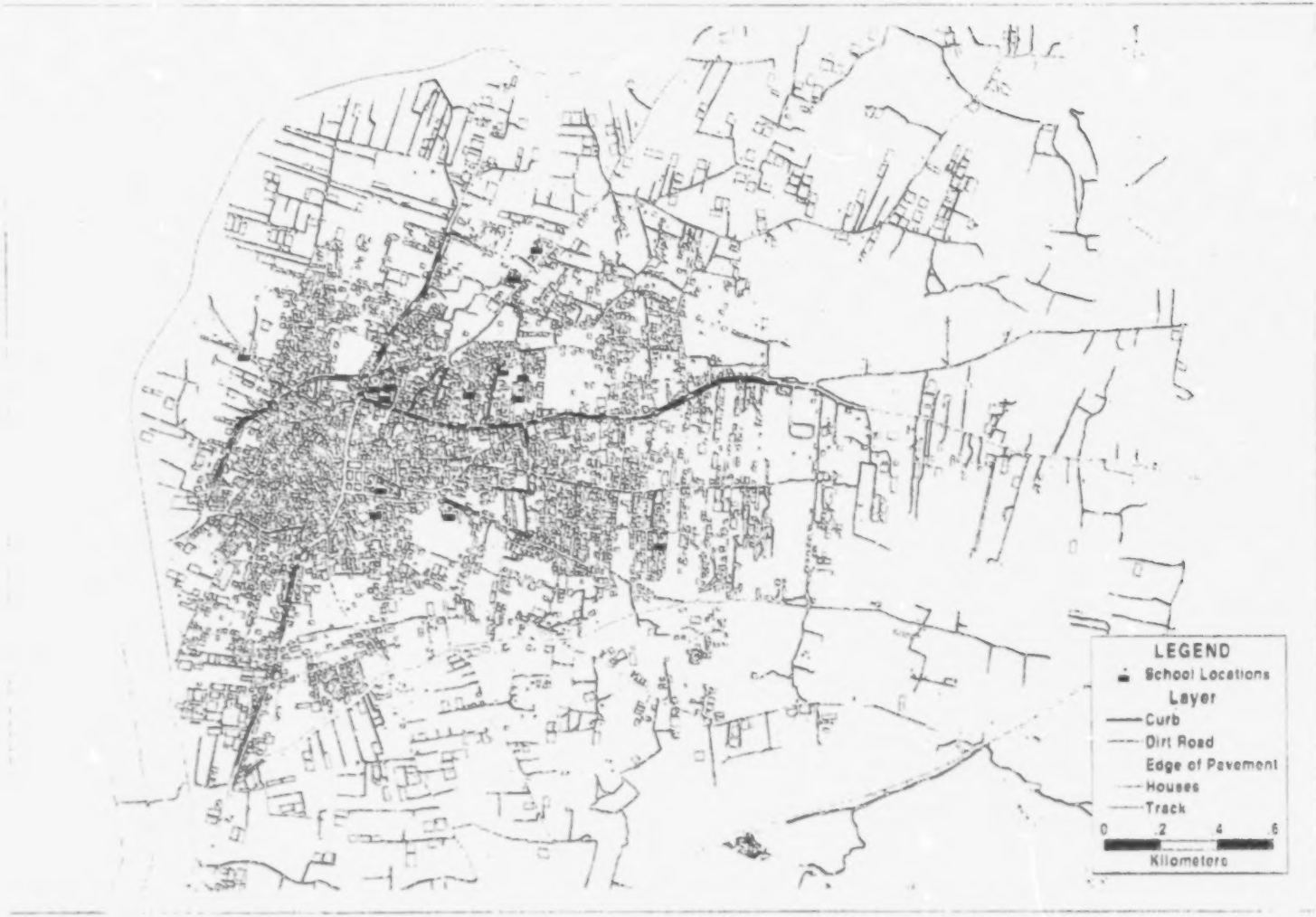

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Figure 7: Village of Falamia

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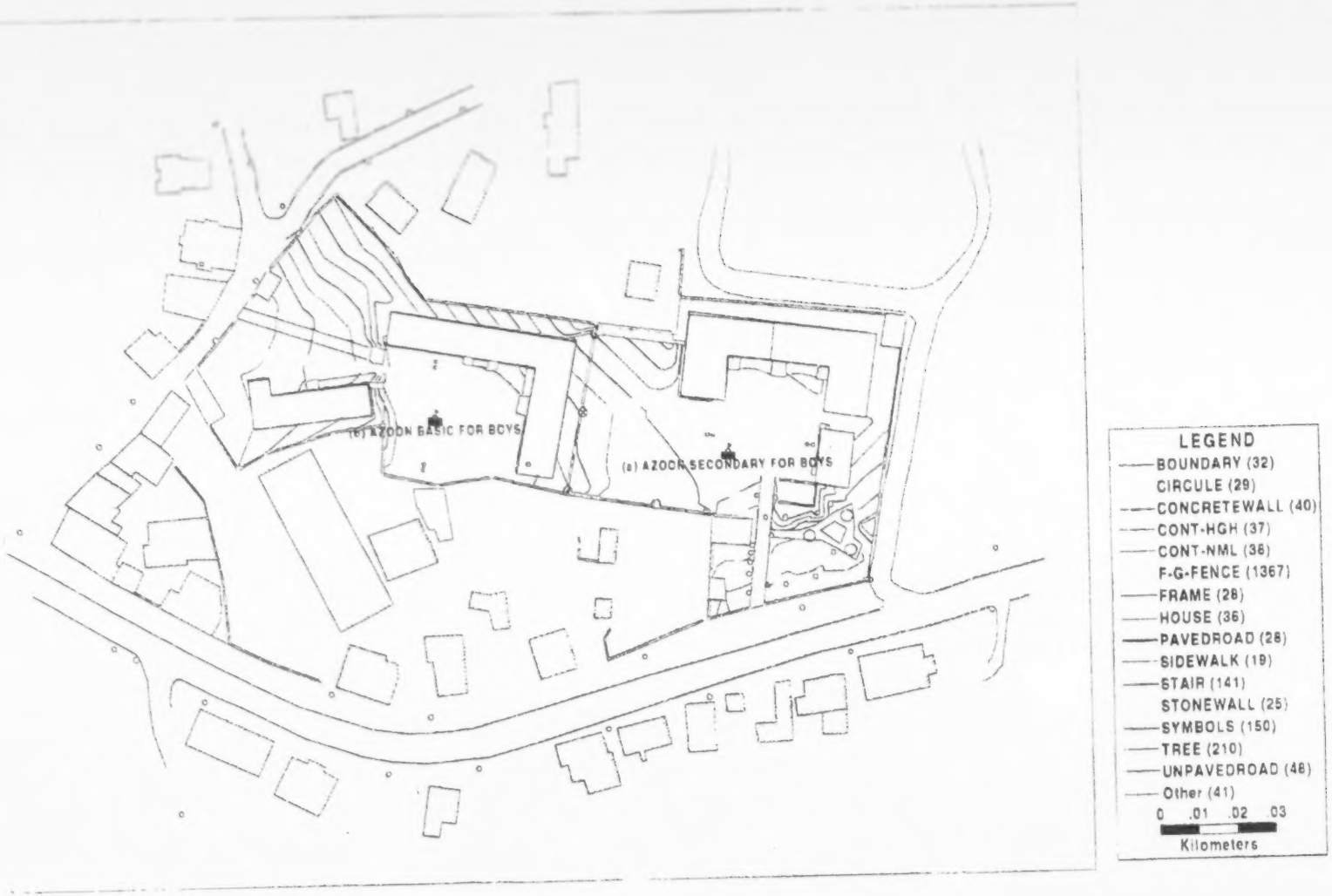
Figure 8: Site Plans – Azoon schools



SETTING UP AND USING A GEOGRAPHICAL INFORMATION SYSTEM FOR MICRO-PLANNING AND SCHOOL MAPPING IN PALESTINE

B. Parolin

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INTRODUCTION

The Palestine School Mapping Project, on which this monograph comments, was launched in September 1997 and was completed in January 1999. The scope of the work involved providing the Palestinian Ministry of Education (MOE) with the capacity to manage and use a Geographical Information System (GIS) and the capability to undertake school planning on a more analytical and integrated basis. It is viewed by certain sections of the Ministry as being of critical importance in the ability to plan the future school system in Palestine. Others in the Ministry viewed it as one of the most important of the donor-funded projects, with the potential for positive outcomes and the promise of enhancing the status of the school planning function to a core responsibility.

The project was always envisaged as being a central Ministry responsibility because, for the time being, the school planning function and the school construction and maintenance functions are in the hands of their respective directorates. Eventually, however, the GIS would be decentralized to a district level following upgrades to computing skills and equipment, and the availability of school mapping databases for respective districts. The central Ministry would manage the resulting two-way flow of information.

The work undertaken for the project required that smaller-scale geographic databases be established for the whole of Palestine (West Bank and Gaza). However, large-scale detailed databases on schools were restricted to one test district. Following completion of the project, decision-makers in the Ministry will evaluate the project and the utility of established school mapping databases, and decide on its possible expansion to cover remaining school districts.

This monograph describes how the GIS on schools and education has been established within the MOE and demonstrates its functionality. Discussion is also focused on the structure of the GIS and its applications for educational micro-planning. An exercise of this type can have a dramatic impact on established work practices (especially in planning), and on organizational and administrative structures. Therefore, the monograph also discusses the difficulties in establishing the GIS and barriers to the appropriation of GIS by the Ministry. Some of the beneficial outcomes of the project on planning and management functions are also highlighted.

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BACKGROUND

Palestinians are currently passing through a phase of national institutional development and socio-economic change as a preamble for the establishment of an independent state.

Occupation by Israel, which commenced in 1967 following the outbreak of war, lasted up until 1994, when agreements were signed between Israel and the PLO for the transfer of authority from the Israelis to the Palestinian Authority (Mahshi, 1999).

The peace process, which commenced in 1991 first with the Madrid conference and then the Oslo Agreement in 1993, has been the catalyst for rapid socio-economic and institutional change in the West Bank and Gaza Strip areas. One key aspect of institutional change has been the creation of the Palestinian Authority (PA) in 1994 and, subsequently, of the Ministry of Education and Higher Education (MEHE) which took over responsibility for the education system in the West Bank.

The MEHE consequently had responsibility for the entire education sector, including government, private and UNRWA (United Nations Relief and Works Agency for Palestinian Refugees) schools. It was responsible for all levels from kindergarten to higher education and all streams – general, vocational and technical. In 1996, a Ministry of Higher Education was established which assumed responsibility for post-secondary education in the West Bank and Gaza. The Ministry of Education (MOE) remained in charge of basic and secondary education.

At the time of the peace agreement, the provision of primary and lower-secondary education in West Bank/Gaza was divided between the Israeli Civil Administration and UNRWA. The United Nations created UNRWA in 1950 to provide basic services in health, education

and social services to Palestinian refugees throughout the region. It offers basic education programmes in West Bank/Gaza using the same curriculum as that of the country which is hosting the refugees. The Israeli Civil Administration continued with the previously adopted practice of dual education systems – the Egyptian system in Gaza and the Jordanian system in the West Bank.

At the time the MOE assumed responsibility for education from the Israelis, the educational infrastructure of the West Bank and Gaza was characterized by neglect, deterioration, and collapse. School buildings were not renovated and suffered severe maintenance problems, and new schools were not built - except those by the private sector or by local communities. This occurred at a time when the school-age population was rapidly expanding as a result of high birth rates. Further, equipment and materials necessary for the improvement of teaching and learning were lacking or non-existent. Students were also adversely affected by interruptions in their studies due to the closures of schools and educational institutions by Israeli military order during the first Intifada (the popular uprising against occupation which started in December 1987 and lasted until 1994) (Mahshi, 1999).

A final point of relevance to the school mapping project was that both authorities since 1967 rationalized school construction and expansion relative to their territorial jurisdiction, rather than to the residential catchment area of schoolchildren. Thus, the placement of schools has not been rationalized across the whole land area. The lack of a territory-wide strategy of siting schools has caused overcrowding in some places, duplication of facilities in others, and some school sites that require schoolchildren to walk as far as six kilometres each way to attend classes. Neither authority had databases that allowed the development of sound and global five- or ten-year plans for school construction and major maintenance (Mahshi, 1999).

Notwithstanding the educational infrastructure and development problems inherited at the time of the peace agreement, the MOE has had to manage a student population which has been growing at a yearly rate of more than 6 per cent over the past four years. In 1997/98 there were more than 838,000 pupils in pre-schools, basic and secondary schools in Palestine (West Bank and Gaza). About half of the total number was female. More than 75,000 of the pupils were in 789 pre-schools and kindergartens; the rest were served by 1,611 basic (Grades 1-10) and secondary (Grades 11-12) schools. The total number of teachers was more than 28,000. Gross enrolment rate in the first 10 grades was almost 100 per cent. It was 52.3 per cent for the two secondary grades. The average rate of drop-out from schools was 2.2 per cent. It was higher among females in secondary grades. Enrolment and retention rates are steadily improving, especially for females (Mahshi, 1999; PNA Ministry of Education, 1998).

During the past two years, the MOE started moving from managing an education system on the verge of collapse to formulating long-term plans for improving educational services. In this regard, it is finalizing a five-year national education plan and has completed the first three-year (1998-2000) development plan that focuses on the following areas and priorities for school education:

- **access to schooling** through rehabilitation, expansion and construction of schools;
- **quality and relevance of education** through curriculum development, teacher training, diversification of secondary education and educational materials;
- **equity** by giving priority to the provision of education to females, to children in rural and remote areas and to other marginalized groups;
- **capacity building** within the central Ministry and the education system at large in the areas of policy-formulation, planning and management.

The Ministry simply does not have the required financial resources to meet the needs identified in its Education Development Plan (Ministry of Education, 1998). From its inception the PA has not been able to include school construction in the national budget (approximately 1 per cent of the MOE budget is from the PNA). Construction of new schools alone (at least 43 schools per year) will require an estimated minimum of US$32 million per year. All activities in this area have been made possible through contributions and grants from local communities and, importantly, from international donors such as the European Union, World Bank, Japan, Germany, Italy, United Kingdom, France, etc. Donor-funded programmes represent at least 90 per cent of the MOE budget in any given year (Mahshi, 1999). One such programme, funded in 1997/98 by the Australian Agency for International Development (AUSAID) and the World Bank, made possible the 'Palestine School Mapping and Maintenance Scheduling Project'.

OBJECTIVES - SCHOOL MAPPING IN PALESTINE

The Palestine School Mapping Project was, therefore, undertaken within the context of a rapidly expanding school system and the need for educational planning in all its facets. Two specific objectives were identified.

- To develop school mapping databases that will allow districts and the Ministry of Education to develop multi-year plans for new school construction and major maintenance.
- To train relevant personnel in the use of these databases - specifically, to train to expert level relevant Ministry and district-level staff in the analytic use and updating of these databases. In most cases, 'training' was to involve staff in the construction and initial manipulation of the databases for budgeting, planning and other purposes.

In essence, the school mapping project was to provide information to planners and management for relating demand for new school classrooms (and schools) to the capacity and location of existing schools across the educational administrative system of Palestine. This would necessitate the development of appropriate criteria and indicators of demand and capacity. Projections of student numbers, with age and enrolment profiles, would then provide a basis for estimating the expansion in capacity needed, the implications for construction and the timing of such construction. Its scope was to enable both strategic planning at a national (Palestine) or regional (West Bank and/or Gaza) level, and also allow for micro-level planning in district offices (local planning), with support from the central office.

The key goal of the project was to provide analytical and mapping capabilities for informed decision-making on future distributions of

educational infrastructure and resources within the context of a national education plan. The ability of Geographic Information System (GIS) technologies to integrate digital map data and spatially referenced school enrolment and demographic data, and its ability to examine spatial relationships, becomes an important element within the MOE for the management of existing and future education assets.

PART I.
USING A GIS IN SCHOOL MAPPING AND LOCAL EDUCATIONAL PLANNING

USING A GIS IN SCHOOL MAPPING AND LOCAL EDUCATIONAL PLANNING

One of the more important objectives of the work undertaken by the consultant was to demonstrate to decision-makers and school planners in the Ministry the range of applications possible with a GIS. At one level this meant the consultant had to foster a sense of the value of 'geographic' and 'spatial' analysis, and of the value of maps for communicating important information about the school system. At yet another level, it meant teaching the decision-makers and planners how to read, understand and interpret maps of the education system – a hitherto missing element in the treatment of educational information.

Following initial compilation of the school mapping databases, with adequate geographical layers to be able to compile maps, the consultant had the trainees generate maps on several scales (small and large) for the purpose of displaying geographical variations in educational information. The sense of satisfaction at this point among trainees must be mentioned, as they were able to view new relationships in the distributions – and to think about education policy implications.

Using a GIS to display regional disparities

Construction of the GIS and associated school mapping databases during 1998 were co-ordinated with an extensive training programme – one aim of which was to empower the trainees to generate computer maps of relevant school data on a regional and district basis.

The following maps were produced to highlight inter- and intra-regional disparities in the location of educational resources:

Types of schools

The education system in Palestine (West Bank and Gaza) is organized into lower basic, upper basic and secondary schools, normally along gender lines. While co-educational schools exist, they are very few in number due to religious considerations. *Figures 1-3* show the distribution of lower basic, upper basic and secondary schools in the West Bank. What is apparent in these maps is the disparate locations of schools of different types. There are many examples of where lower basic schools are not located close to places having upper basic schools, and similarly for secondary schools. For example, the district of Qalqilia and the southernmost school district (South Hebron) are characterized by this particular distribution: basic schools tend to be clustered in one part of the district, while secondary schools predominate in another part.

The above examples serve to highlight the additional travel distances faced by students in villages which are not within reasonable distance of upper basic or secondary schools. Walking distances of six kilometres each way to attend classes are not uncommon in some districts. This has stemmed from lack of a territory-wide siting strategy for schools in the pre-1994 period.

On the other hand, the distribution of schools also serves to highlight that many schools are so close to each other that they could be regarded as being in each other's residential catchment area, and hence the respective schools' catchment areas. For example, many localities with basic schools in Qalqilia district lie within 2.5 kilometres of each other. The result of such close and overlapping spacing of schools has resulted in duplication of facilities. There is recognition by the central planners in the Ministry that planning by the Israeli administration in the pre-1994 period failed to take account of the hierarchy, size and spacing of settlements in Palestine. School

construction and expansion in this period were accommodated relative to a territorial jurisdiction, rather than to the residential catchment area of schoolchildren.

As a result of the insight gained by creation of the above maps, the Planning Unit within the General Directorate of Educational Planning, Research and Development initiated a study aimed at identifying schools which can be consolidated with nearby schools in order to avoid duplication of facilities. The intention is not to close schools, but to ensure that schools meet the needs of respective communities (localities), thereby ensuring optimal use of facilities such as buildings and equipment, and minimal overlap in their catchment areas.

Localities with no schools

While the distribution of localities with schools indicates overlapping catchment areas, there exist many localities without provision of any formal educational institutions, even in more densely populated districts such as Qalqilia (*Figure 4*). It is Ministry policy, as articulated in the first three-year national education plan, to ensure access to school for all Palestinian children. In effect, this means that no community will be without a school. In the longer term, the Ministry will examine such localities to determine the type of school(s) that should be constructed at these sites.

Figure 4 indicates that many localities without schools tend to cluster within the proximity of localities with schools, even in the more rural areas of particular school districts. This indicates that some type of student transport scheme may be feasible in order for students to access the closest schools. While this possibility has been discussed in the Ministry, the consensus is that the costs of such a scheme are prohibitive.

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Using a GIS for micro-planning

An array of maps was generated as part of the consultants' involvement with the strategic plan for the Qalqilia school district. These maps deal with the distribution of existing and future educational resources within that particular district (the latter maps are not shown).

Distribution of schools by type

A series of maps was generated to indicate the location of schools within a locality and the type of school at each locality. *Figure 5* provides an immediate indication of the location of basic and secondary schools, and the gender attending each school in the Qalqilia district. This map provides the school planner with detailed information on the mix of schools at various locations and where there may be a need for new schools, or schools with an expanded curriculum.

For example, the villages of Beit Amin, Izbet al Ashqar and Ras at Tire, in the south, and the village of Sir only have schools offering up to Grade 6. (In some cases, schools at these sites only offer up to Grade 3). This highlights the need for schools with grades above Grade 6 – an upper basic school. The village of Kufr Thuluth, on the other hand, has two secondary schools but no basic school, which means that schooling for Grades 1-6 requires travel to a nearby village, the village of Azzun in this case.

Similarly, the villages at the eastern end of the district only provide upper basic or secondary schools, and not lower basic (Grades 1-6) schools. For female students, the closest village offering a lower basic school is Jinsafut, while for male students there is a need to travel to Hajja. This type of information is crucial to the strategic planning

exercise for the district of Qalqilia – to identify where new lower basic, upper basic or secondary schools were required. The EMIS data on projected student numbers were then used to determine how many classrooms, teachers and other facilities were required.

Exact location of schools

Another school mapping database consists of large-scale maps which provide exact co-ordinates of school locations and the physical infrastructure of respective schools. In turn, these maps can be superimposed on digital maps of village or town street networks in order to provide additional information on immediate areas surrounding a school, location of a school relative to the entire locality, constraints to school expansion, and possible amalgamation and rationalization of school facilities.

Figure 6 shows the exact locations of all schools found in the City of Qalqilia. The city itself is displayed as a street network and cadastral layer (property boundaries).[7] The map shows the relative concentration of schools in only a few parts of the built-up area of the city, and not in others. In addition, by using the zoom tool in the GIS software, one is able to see what features surround a school, and whether there is a possibility for school expansion.

Figure 7 (village of Falamia) is an example of a map with mid-scale digital street data for villages, purchased from the Palestinian Central Bureau of Statistics. This map differs from that of Qalqilia (*Figure 6*) in that it does not show property boundaries, rather it highlights existing structures such as buildings, barracks and schools, and outlines structures under construction. The exact location of the

7. These data were provided to the Ministry as an AutoCAD DXF file. All school locations are mapped in British Palestinian Grid co-ordinates, and were measured by photogrammetric engineering consultants using a sophisticated global positioning system device.

school was added as a layer. *Figure 7* indicates that the school is in a central location relative to the built-up area of the village, and that there is ample space surrounding the school for possible expansion or construction of a completely new school. One reason for obtaining digital data like these is to allow the school planners the ability to locate schools accurately relative to features in a locality and to provide a list of additional and feasible sites for any new school(s) within a locality.

Other possible uses

School site and survey plans

The following is an example of school site plan data for two schools in the village of Azoon (*Figure 8*). These data are provided by other services in AutoCAD DXF format, together with digital files of detailed architectural drawings of the school and the survey plan of the school.

Figure 8 shows the exact boundaries of the two schools, the number of buildings on each site, surrounding neighbours and properties, and access to the school. For these particular schools, any future territorial expansion appears to be limited to that of a vertical nature as a result of surrounding land uses.

Data for the survey plans of schools and corresponding architectural drawings (in digital form) (not shown) give precise information on the following:

- buildings and classrooms (and their uses);
- facilities at the school site (sanitary units, drinking fountains, main gate(s), laboratories, canteen, etc.);
- dimensions of all infrastructures, including the site itself.

These data, which have been collected for all schools in the Qalqilia test district, have so far been used by school planners and architects in the Ministry for the following:

- To assess the possibilities and implications of modifications and/or extensions of buildings and classrooms at central MOE and district office through digital simulation within the office.
- To examine the presence or absence of facilities at respective schools (e.g. sanitary units, drinking fountains, main gate, boundary walls, canteen, etc.).
- To determine if facilities are adequate for the school, in function of its size: e.g. is there a sufficient number of drinking fountains for a school of this size; are there adequate sanitary units? The existing number of facilities can be compared to the MOE standard.
- To calculate the amount of space in square metres devoted to teaching and non-teaching functions in the school. These data, when linked with school demographic data, provide a basis on which to calculate indices of overcrowding or undercrowding at schools (e.g. pupils per square metre for teaching and non-teaching areas).

The latter example is intended to allow the Ministry and its district-level staff to determine in an informed way standards for facilities across Palestine, such as: minimum space requirements per pupil for various types of schools (e.g. square metres per student in basic or secondary school), the required space of facilities in schools (e.g. square metres for a library in a secondary school, etc.), or the number of pupils per facility.

A final use of the school site plan data is that they provide an inventory of all facilities, buildings and classrooms at respective schools that can be used for maintenance assessment purposes. For example, site plans were used by the Qalqilia district engineer to

assess the maintenance condition of classrooms, buildings and facilities at respective schools. The architectural plan acts as a register of items for assessment by the engineer. As each item is completed, it is marked off on the hard copy of the site plan.

Further, architectural plans of a school provide dimensions which enable the engineer to measure the amount of maintenance work to be undertaken in a particular classroom or building (e.g. amount of paintwork in square metres required in a classroom, or the amount of tiling that needs to be replaced on a classroom floor, or the length (metres) of repairs to the school boundary wall, etc.).

It needs to be stated that school site and survey plans, and corresponding architectural drawings, represent a wealth of information for the central MOE and for district staff. Most of the engineers at district level have not previously seen or worked with digital site plans or architectural drawings. The MOE up until 1997 only had site plans for about 30 per cent of Palestinian schools, and many of these were out of date and not complete in the details required for facilities management.

PART II.
SETTING UP A GIS ON EDUCATION: A TECHNICAL EXERCISE

SETTING UP A GIS ON EDUCATION: A TECHNICAL EXERCISE

The question of why a GIS was necessary, and how it was intended to be used as an important tool in educational planning and management, had been established prior to the arrival of the external consultant. The work of the external consultant involved, among other things, setting up a GIS and training Ministry personnel in its use and applications.

Planning a GIS

The following phases were involved in setting up a GIS in the Ministry:

- *Phase One:* Preliminary assessment of GIS needs

An initial site visit to the MOE was made by the external consultant to assess the various data, software, hardware and training needs required for the project (Parolin, 1997*a*). This proved a very fruitful exercise as it enabled detailed assessment of:

- Extent of availability of digital data layers and which organizations could provide required data. Of necessity, this also allowed assessment of what data layers were not available and would have to be generated internally.
- Quality of available data from various providers.
- Costs, if any, to the Ministry of various data sources.
- Extent of availability of education data (EMIS) in the Ministry.
- Assessment of level of technical and computing expertise in the Ministry and at district level.
- Assessment of GIS software and hardware requirements given existing and future needs, and recommendations for their purchase.

- Phase Two: *Purchase and installation of software and hardware*

This was completed in the first month of the consultancy and involved setting up both software and hardware for use with PCs required for the project.

- *Phase Three:* Procurement of small- and medium-scale digital map layers for Palestine

A further section of this paper comments on what this phase consisted of.

- *Phase Four:* Developing large-scale digital layers

The external consultant prepared a brief for expert consulting services to be provided by professional surveying and/or architectural and engineering companies. The brief called for survey and site plans and detailed architectural drawings of each school in the Qalqilia test district. A two-month time limit was given to complete the work.

- *Phase Five:* Linking map layers with EMIS data in GIS

A considerable amount of time was spent on merging the various schools' databases (geographic map layers and EMIS data) into the GIS for analysis and mapping purposes. In essence, this phase completed the set-up of database systems required for the project. A critical requirement of the project was to have the trainees assist in this important process.

- *Phase Six:* Capacity building – training programme and applications

An intensive GIS training programme was conducted which lasted for a period of nine months, and was held concurrently with phases

two through five. A critical component was for the trainees to assist in building and using parts of the schools' database for educational planning purposes.

Acquiring the software and hardware

Most software and hardware available in the Ministry lacked the necessary technical specifications to enable setting up and using a GIS. Computing equipment (PCs) prior to commencement of the project was characterized as obsolete, with most PCs being of the 486 variety (a few low-level Pentium PCs were available, mainly by those running the EMIS). Printing equipment was also inadequate for GIS work, with no capacity for colour printing or A3-size output. A complete upgrade of the computing and hardware environment was required as a prelude to the establishment of the GIS. Practically no capacity existed at the district level for GIS work, mainly because the technical and computing skills of personnel at this level was of a lower standard, and because of the unavailability of required computer equipment.

Further, the only relevant software at the time in the Ministry was AutoCAD (used by the General Directorate of Building and Projects) and MS Excel and MS Access (used by the General Directorate of Educational Planning, Research and Development). Unfortunately, the AutoCAD software lacked technical support and relevant manuals for digitizer set-up, digitizing procedures, and attachment of attributes to objects.

(a) GIS software

The external consultant evaluated several desktop GIS software packages for the project: MapInfo 4.1, GENAMAP, TRANSCAD 3, ARC/View 3.0, and Maptitude 4. It was recommended that Maptitude Version 4 for Windows 95 be purchased from Caliper Corporation (USA).

Five copies of the software were purchased at a cost of A$800 or U$S395 per copy (a total of US$1,975). It should also be stressed that Maptitude was the lowest priced of the desktop GIS packages examined. The programmers' development kit (GISDK) for Maptitude, which is sold separately (A$800), was also recommended for purchase. This would allow special applications to be developed and linked to the main GIS.

The advantages of Maptitude for this particular project, particularly over the MapInfo and ARC/View software, were assessed as follows:

- added capabilities for import/export of different file formats;
- a larger array of colour combinations available for map production;
- additional capabilities for linkages to external databases;
- availability of a simple-to-learn programmers development kit (GISDK); and
- ease of learning the software.

Further, it was recommended that the Ministry of Education purchase five copies of the latest version of AutoCAD (version 14) software for Windows 95 (at a cost of A$5,495). AutoCAD was to be used for the management of existing and new school survey plans, site plans, architectural drawings, and the subsequent update of plans and drawings.

In hindsight, the selection of Maptitude was an excellent choice for several reasons. First, the GIS trainees were able to learn the basic and more advanced features of GIS very quickly, and to begin thinking in 'GIS' terms much earlier than otherwise might have been the case. Second, it facilitated the design, set-up and use of the schools' databases which have subsequently been used for analysis and map production as part of general school planning, as part of the strategic planning exercise for the test district of Qalqilia, and in preparations for the first five-year plan.

(b) Hardware

It was the Ministry's responsibility to purchase the necessary computers and printers for the GIS project, using the recommendations of the consultant. It was recommended that five Pentium 266 PCs with at least 64 Mb RAM and a 4 gigabyte hard disk be purchased (a three-year warranty period was also specified). Each Pentium PC was to be connected to a 21-inch SVGA monitor for enhanced graphics and GIS functionality. Also, the Ministry purchased two Cannon Bubble Jet 4550 colour printers with A4 and A3 capacity for exclusive use in the GIS project. These items were all purchased, installed and operating by the time the external consultant commenced phase two of the project.

Apart from these initial recommendations, the only other hardware requirement was for the purchase of a quality digitizing tablet which would be attached to the GIS software and to AutoCAD. Its purpose was to enable efficient and accurate digitizing of larger (wall size) topographic maps containing features and layers of relevance for inclusion in the schools' mapping databases.

Purchase and installation of a Calcomp A0 size digitizer (US$5,900) occurred in phase two of the project. Many practical exercises were given to the trainees on how to use the digitizer with both AutoCAD and Maptitude. In addition, the trainees were shown how to set up and calibrate the digitizer for the above software packages – a detailed technical note was prepared for this purpose.

Data collection and input

(a) The data

The construction, development and validation of school mapping databases for the project involved the collection of mainly geographic data at various scales. The types of geographic data to be collected

had, to some extent, been previously defined by the project proponents in accordance with the project brief. In addition, the external consultant made many recommendations regarding the need for additional geographic layers or other digital data which would enhance the completed databases and provide additional analytical capability. The following data were collected:

- Digital map data at smaller scale for the West Bank and Gaza Strip areas to show socio-economic features (e.g. locations of Palestinian communities, built-up areas of Palestinian communities, etc.), physical features, access routes, geographic features and contours, political features (e.g. governorate boundaries) and the locations of important public structures. These data have been collected and imported into the GIS system, and provide the background on to which can be superimposed more detailed information regarding the locations of schools and their attributes.

- Mid-scale digital map data from the Palestinian Central Bureau of Statistics (PCBS) containing street networks of villages in the Qalqilia school district. Street network data for each of 29 villages were purchased. These data indicate the locations of all streets, roads and building types in respective villages, including the outline of school buildings.

- Development of CAD databases in digital form on the physical infrastructure of schools: school survey plans, site plans and school architectural plans. These data have been prepared for the pilot-study district of Qalqilia (school district). Various components of these data have been linked through the GIS to the geographic location of schools in the district.

These data provide more detailed information on a larger scale, such as the exact location of a school in British Palestinian Grid Co-

ordinates (shown as a point), the exact boundary of the school (school site plan), the physical features located at the school site (e.g. buildings), and architectural plans for all buildings located at the school.

Table 1 presents a list of all geographic map layers obtained and developed as part of the school mapping databases. The name and description of each layer is summarized from a documentation report which had been prepared as part of the outputs for the school mapping tasks (Parolin, 1999).

Further, the following graphic data have been developed and added to the databases:

- School photos of every school in the Qalqilia district were obtained by the district engineer, and subsequently scanned and saved as bitmap images by the consultant. These image files were then referenced to geographic information on the location of schools.

- Survey plans in AutoCAD format for all schools in Qalqilia have been edited and exported in bitmap format. These image files are also referenced to geographic information on the location of schools.

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Table 1. Description of geographic map layers

Layer name	Type of layer	Description	Comments
arab_ar.dbd	Area	Arab built-up areas	No attributes: 3468 areas
arab_l.dbd	Line	Arab built-up areas	No attributes: 4206 lines
arab_p.dbd	Point	Arab localities as points	Some attributes (Name, PCBS id) : 500 localities
contour.dbd	Area	Elevation 100m	No attributes
co_ord.dbd	Line	Grid covering all Palestine	
cul_site.dbd	Point	Cultural sites in Palestine	With updated names
dead_sea.dbd	Area	Dead Sea	
dist_lin.dbd	Line	District borders	Old district borders
grid.dbd	Line	Grid covering all Palestine	Same as co_ord.dbd
israeli_l.dbd	Line	Israeli settlement areas	No attributes: 313 areas
israeli_p.dbd	Point	Israeli settlements as points	Names: 176 points
m_sea.dbd	Area	Mediterranean Sea	
major.dbd	Area	Ten major cities in the West Bank	With names
pcbsvill.dbd	Area	Arab built-up areas	Attributes; 500 localities
river.dbd	Line	Jordan River	
roads.dbd	Line	Divided into three classes: MAIN, REGIONAL and LOCAL	Contains information on bypass roads
s_points.dbd	Point	Israeli settlement locations	With names
s_poly.dbd	Area	Israeli settlement areas	With names
topog.dbd	Area	Elevation 100m	Attributes (e.g. elevation)
w_border.dbd	Area	West Bank border	
admin_ar.dbd	Area	Admin areas in Palestine	Used to create Palestine State map
admin_ln.dbd	Line	Admin areas in Palestine	Same as above (but a line layer)
areas.dbd	Area	Admin areas West Bank	Uses old admin areas
gaza1.dbd	Area	Admin area for Gaza	
gridfix.dbd	Line	Grid for Palestine	British Palestinian Grid
oslo.dbd	Area	Oslo Peace Accord areas	
roads.dbd	Line	Roads for West Bank and Gaza. Divided into 3 classes: REGIONAL, MAIN and LOCAL	No information on bypass roads
wadis.dbd	Line	Wadis in Palestine	
builtup.dbd	Line	Palestinian built-up areas	No attribute information
govern.dbd	Line	Political governorate boundaries	Up to date as of September 1998
pop1.dbd	Point	West Bank localities	Contains names and PCBS id numbers for 659 localities
Pop_all.dbd	Point	West Bank and Gaza	Attributes for 701 localities
Isr_sett.dbd	Point	Israeli settlements	Contains names of 200 settlements
Road_hwy.dbd	Line	Freeways in Palestine	No attribute information
Road_reg.dbd	Line	Regional roads in Palestine	No attribute information
RoadMain.dbd	Line	Main roads in Palestine	No attribute information
Rd_local.dbd	Line	Local roads in Palestine	No attribute information
Villages.dxf	Line	Village street files for Qalqilia district	Contains layer attributes

Note: The above table only shows geographic map layers. PCBS stands for Palestinian Central Bureau of Statistics.

Two additional sets of data are crucial to complete a fully-fledged school mapping database. These provide both existing and projected information for each school.

- *Schools database:* collected annually by the Ministry as part of its Education Management Information System (EMIS). It is an extensive source of information on the demographic and physical characteristics of each school, its teachers and its enrolment. Many variables from this database, such as enrolments by grade and gender, teaching and non-teaching staff, classrooms, and utilities available at the school, etc., have been extracted into Excel worksheets and then imported into the GIS for mapping purposes.

- *Projections database:* developed by the Head of the Planning Division and containing projections of the number of students (by grade and gender), classrooms and teachers by school for each government school in Palestine. Certain elements of this database have been extracted into Excel worksheets and also imported into the GIS for mapping purposes.

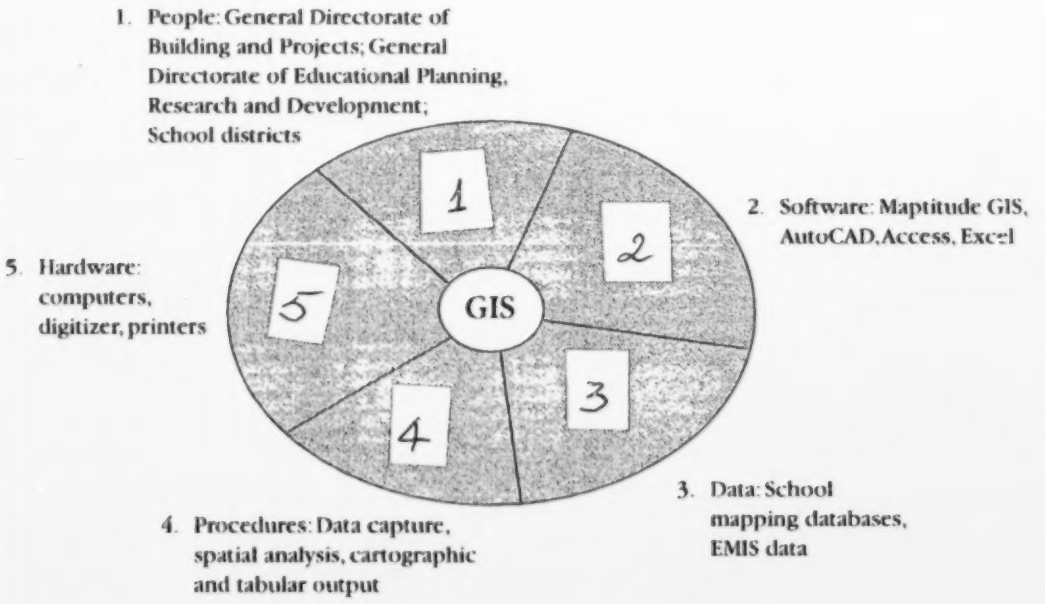
The structure of the GIS database established within the MOE enables planners and managers to open several interrelated layers and to move from small- to large-scale data layers with corresponding attributes. School survey and site plans, and architectural drawings in DXF format can be added as a layer to the GIS or examined separately using AutoCAD software.

In essence, an information system has been developed which can be used at both the central and the district levels.

The GIS established within the Ministry represents an interrelated system which is dependent on five different components (*Figure 1*). It is more than just the school mapping databases, or software, or

hardware; the system relies on all five components working simultaneously. In the longer term, the Ministry expects to enhance the GIS by linking other databases currently under development which also contain spatially referenced data; for example, the furniture register, the employees' database (which includes teachers). Therefore, the use of GIS will extend beyond its current role in school planning.

Figure 1. Components of a GIS


1. People: General Directorate of Building and Projects; General Directorate of Educational Planning, Research and Development; School districts
2. Software: Maptitude GIS, AutoCAD, Access, Excel
3. Data: School mapping databases, EMIS data
4. Procedures: Data capture, spatial analysis, cartographic and tabular output
5. Hardware: computers, digitizer, printers
GIS
1
2
3
4
5

(b) The collection process

In establishing a GIS for the Ministry it was apparent that an excellent database on education (EMIS) already existed within the General Directorate of Educational Planning, Research and Development. It was not the task of the consultant to assess these data for accuracy or validity (it was assumed that the EMIS data were as correct as possible), only to utilize relevant parts of the data for analysis and map-production purposes. In fairness to the Ministry,

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extensive resources had been devoted to collection of these data on an annual basis, and to their validation.

For the geographic data, several sources were identified as part of the initial site visit. It became the sole responsibility of the external consultant to collect all relevant geographic data. The following sources were used:

- Palestinian Geographic Centre (PALGRIC): this centre was the major source of digital data on Palestine. Both vector data and raster satellite data are available in different formats. PALGRIC is charged with development of a land information system for Palestine, and for monitoring and updating geographic layers (e.g. roads, settlements, localities, forests, and rivers). PALGRIC geographic layers are developed using ArcInfo and were provided to the consultant in ArcInfo export format (E00).
- Ministry of Planning and International Co-operation (MOPIC): within MOPIC there exists a GIS unit which stores a collection of digitized geographic files of relevance for planning purposes (e.g. boundaries, roads, settlements, built-up areas, *wadis*, hospitals, cultural and tourism sites, etc.). Many of these layers were initially obtained from PALGRIC and then enhanced or updated to include other attributes. MOPIC geographic layers were made available as ArcView shape files (SHP).
- Palestinian Central Bureau of Statistics (PCBS): this centre provided two types of data:

- a geographic layer in DXF format of the built-up areas of Palestinian communities and their corresponding attributes, such as census identification number and estimated 1996 population, and
- digital line layers in DXF format of all 29 villages located in the Qalqilia district: includes street lines, commercial and residential

building boundaries, school-building boundaries, roads, and other layers.

The latter data were generated by PCBS as part of its policy of digitizing all localities in Palestine for census data-collection purposes. Each digitized locality contains boundaries for all buildings – all households occupying a building were interviewed for the census. In the longer term PCBS will use these data to develop a system of street addresses and street names for each locality. In addition, PCBS plans to develop a digital layer of census enumeration districts for each locality.

- Private sector: a private company in Palestine providing advanced geomatic and surveying services for government authorities, municipalities, and the private sector generated the required large-scale data for the project. This company won the tender to provide the Ministry with school site and survey plans and architectural drawings in digital format. Advanced global positioning system (GPS) technology was used to accurately locate co-ordinates for required features such as school boundaries and buildings. All data were provided in AutoCAD DXF format. This company also prepares digital cadastral layers (DXF format) for municipal planning and engineering purposes and had completed approximately 70 per cent of the West Bank under a contract agreement with the Ministry of Local Government. The MOE had obtained permission from this Ministry to access all municipal data as they became available.

As a result of the range and type of data collected for the GIS, it was not necessary to digitize additional layers from topographic maps. The only other layer generated by the consultant was of the various education districts in Palestine.

The collection of data for the GIS tended to proceed smoothly and was, for the most part, collected on time. However, there were long bureaucratic delays in the transfer of some data to the consultant as a result of previous experiences in dealing with the MOE (i.e. non-payment for data). In some instances, the Ministry was required to pay for the data, and delays were created due to the unwillingness of the Ministry to pay another PA Ministry. In yet other instances, an organization would only provide data to the Ministry if it compensated the provider with much-needed computing equipment.

(c) Entering data

It was fortunate for this project that all geographic data collected had also been generated by means of GIS and were therefore available in digital form. These files were normally given to the consultant in export format. It became a simple process to import ArcInfo export files (E00) or ArcView shape files (SHP) or AutoCAD (DXF) files into the Maptitude GIS. The consultant and GIS trainees accomplished this task.

Once imported into Maptitude with correct specifications, these files were then saved as Maptitude geographic files (DBD). All DBD geographic files are linked to a relational database which uses DBASE (DBF) as its format.

All data pertaining to the EMIS were collected, validated and entered into the computer by personnel from the data entry division of the General Directorate of Educational Planning, Research and Development. Several of the GIS trainees from that directorate, those from the Division of Statistics and Division of Planning, had the responsibility of extracting required school data (e.g. school size, school gender, school type, projections of students and classes) for mapping purposes. These data were provided to the consultant in

either Excel or Access format and were joined to the geographic map data in Maptitude to create a joined view which then allowed analysis of the data and creation of thematic maps.

The consultant trained the various GIS trainees in procedures for the conversion of files to Maptitude format and for the joining of school data to geographic map data. However, the consultant had the final responsibility for ensuring that all data files were accurate, and for the assembly of the various school mapping databases – including the joined dataviews to be used for mapping purposes.

All the data described in *Table 1*, which form the geographic data layers, plus all other data described above were entered into one of the five Pentium computers purchased for the project. These data were subsequently copied to the remaining four computers for training purposes. Towards the end of the consultant's term, following purchase of adequate computing equipment in the test district, the engineer and planner of that district subsequently transferred the data to district computers for use.

Data checking, integration, storage and planning

The consultant devoted a considerable amount of time to defining, obtaining and checking the accuracy of all data described above (the validity of the schools database is verified by the Statistics Department of the MOE) which form the basis of the school mapping database. All digital geographic data have been carefully checked for accuracy by using AutoCAD and the GIS to examine the location attributes of the data. Any incorrect data layers were returned to the source provider and a clean data layer provided.

Geographic data layers obtained from PALGRIC or MOPIC were often the same layer, but digitized and created with relevant

attributes for differing purposes. This provided a check on the accuracy of these layers through the simple process of overlaying them using Maptitude. Problems were encountered with these layers on several occasions - errors in digitizing which resulted in overshooting or undershooting of polylines, plus simple carelessness in placement of digitized lines relative to their true location on the topographic map. In addition to checking via the overlay facility, all geographic layers and their features were visually checked against detailed hard-copy topographic maps purchased from PALGIC and from the Survey of Israel. Any geographic layer containing errors was returned to the relevant data provider with a list of errors and corrections required. Subsequent copies of the data underwent further checking for error correction.

Two minor technical problems occurred:

- On several occasions files of geographic data were provided which could not be opened and subsequently imported into Maptitude - this was a common occurrence with AutoCAD files during the early stages of the project. It appears that AutoCAD files provided to the consultant had been locked by the data provider (a facility in earlier versions of AutoCAD) when the files were initially saved in AutoCAD format. It also meant AutoCAD in the MOE could not open them. (The simple practice of not locking files solved this problem.)
- Another recurring problem in the early stages related to the inability of Maptitude GIS to import AutoCAD version 14 files provided by PCBS or the tender company. This problem was solved by importing these files to AutoCAD and saving them as AutoCAD version 13 files - they were subsequently imported into Maptitude without problems (Parolin, 1998).

The consultant prepared a report which documents all of the data sets developed for the school mapping project and which was made available to relevant persons in the Ministry and to the GIS trainees. This report details how the data are stored within the GIS, in particular the structure of folders and sub-folders according to type of data and its purpose (Parolin, 1999).

A clean copy of all school mapping data sets has been placed on the two file-servers used in the Ministry, and also on several CD-ROMs. Copies of the CD-ROMs have been given to the Directorate of Building and Projects and Directorate of Planning, Research and Development.

In the near future the Ministry is likely to expand the school mapping databases, in particular the CAD databases, to include other school districts. Additional digital data will also be available from existing providers such as MOPIC, PALGRIC, and PCBS. For example, the impending release of the 1997 Population, Housing and Establishment Census in digital form will provide the Planning Division in the MOE with invaluable data for more accurate estimates of population growth and, in turn, growth in student numbers.

In the longer term, PCBS intends to digitize all census enumeration districts (the spatial unit for the 1997 census) and to provide census information for such districts. This development will also provide the MOE with data required for the analysis of school catchment areas, and for micro-level school planning.

During the last phase of the project, the consultant and those responsible for the project in the Ministry discussed the implications of the above developments. A recommendation was made to the Ministry that serious consideration be given to the establishment of a GIS unit for the management of existing and potential school mapping data. In addition, it was recommended that the position of

GIS data manager be created. The data manager would be responsible for all school mapping databases – their access, sharing and updating. In addition, this person could act as a liaison with other data providers in Palestine and keep abreast of newly available data of relevance for school planning needs.

Detailed procedures for accessing, sharing and updating school mapping data in the Ministry, and between the districts and the Ministry, will be developed once a detailed review of the GIS project has been undertaken. However, as mentioned previously, the decision-makers in the Ministry always envisioned that there would occur a two-way flow of the school mapping data sets – the only limitations at present are inadequate computing equipment, computing skills and GIS training in the districts. However, upgrading skills and equipment has to be a long-term process. In the meantime, all school mapping databases and the GIS will be fully utilized in the central Ministry – especially between the two key directorates: General Directorate of Building and Projects, and General Directorate of Educational Planning, Research and Development.

PART III.
SETTING UP A GIS ON EDUCATION: A CAPACITY-BUILDING EXERCISE

SETTING UP A GIS ON EDUCATION: A CAPACITY-BUILDING EXERCISE

GIS training programme

The training programme commenced in February 1998 and lasted over a period of nine months. Using criteria specified in the project management plan, those responsible for the project in the Ministry selected a total of 13 persons to undergo the GIS training programme (Parolin, 1998). By the end of the project 10 trainees remained - a few resigned due to personal and work commitments, and one for medical reasons. The trainees were made up of architects, engineers, planners and statisticians.

The 10 trainees who completed the programme during phase two, and who undertook the more advanced training during phases four and five, included members of staff from the central Ministry in Ramallah (namely two from Building and Projects and two from Planning, Research and Development) and from district offices (namely one from Jenin, one from Qalqilia, one from Bethlehem, and one from South Hebron). Personnel from the districts were selected as part of the Ministry's effort at decentralizing management - these persons will form a core group to train others in their respective districts.

During phases two and three, the training programme was held for four days per week. It became necessary to have longer weekly sessions given that at least half of the trainees lack basic computing skills. Following several weeks of intensive GIS training, and training in Windows 95 and Excel, most of those with lower-level skills were able to reach a level where they could work with the GIS.

The 10 trainees completed all assigned tasks and have understood the concepts and their applications. At least four of the trainees have achieved very high levels of performance in all assigned tasks, have attained a deeper understanding of the concepts, of the various software programs utilized and, as a consequence, a higher level of understanding of the range of applications for educational planning and management. (Included among the four is the head of the Planning Division – a person who uses the GIS on a daily basis.)

While the GIS training programme can be considered successful by any measure, it was stressed to the Ministry that GIS work is associated with a very steep learning curve. The most efficient way to foster higher-level learning in GIS, especially as it relates to educational planning and management, is to encourage the four top trainees (and others) to participate in advanced training programmes at overseas locations.[8]

(a) Training format and exercises

The training format initially consisted of informal lecture sessions followed by demonstrations on the computer. This was then followed by practical sessions in which the trainees were given substantial exercises to be completed under minimal supervision. The philosophy throughout has been 'training on the job'. What has assisted in making the training more meaningful and relevant has been the use of local data for all tasks – data obtained as part of the school mapping data sets during phase three to five.

8. One such location, among others, could be Sydney, Australia where the University of New South Wales conducts specialized GIS training programmes. Further, in coming to Sydney, the trainees would be able to observe first hand the workings of the GIS unit in the New South Wales Ministry of Education – a unit which in the opinion of the consultant is using world's best practice in the application of GIS to educational management issues.

Topics covered in the training programme are listed below:

- DOS, Windows 95, Access, and Excel refresher;
- introduction to GIS principles, concepts, and file formats;
- introduction to GIS databases and database design;
- on-screen digitizing (with mouse as pointer);
- digitizing using a Calcomp A0 digitizing tablet;
- checking and cleaning of digitized data;
- scanning of images;
- vector map display;
- polygon, line and area objects;
- map encoding;
- working with raster images;
- annotation and map output;
- windowing and co-ordinate transformation;
- using dataviews and data tables;
- linking to outside databases using ODBC;
- map design, layout and production;
- map overlay functions;
- GIS analysis functions.

A package of 15 training exercises was prepared, including two larger project work tasks that required the trainees to integrate knowledge from the exercises to accomplish larger-scale applications. The exercises were structured so they relied on the use of the schools' data and digital map bases obtained as part of the initial system design, and data obtained as part of the tender work for the Qalqilia pilot district. The latter data have been used extensively during the advanced GIS training programme in phases four and five. The major focus of these exercises has been on learning how to import data from various sources, database design, building a GIS, and the application of GIS for school planning and management purposes.

These exercises covered the following topics:

- using colour themes for map generation;
- co-ordinate systems and data conversion;
- table and database structures in GIS;
- manipulating tables and databases (joining, selection sets);
- basic map design and layout;
- working with point, line and area files;
- on-screen digitizing and layer creation;
- using Excel for database design;
- using AutoCAD for polyline drawings;
- importing AutoCAD files to GIS format;
- using AutoCAD to calculate properties of line features;
- digitizing maps using the CALCOMP digitizer;
- using AutoCAD with the CALCOMP digitizer;
- GIS analysis functions (overlay, bands, buffering, areas of influence);
- advanced GIS functions (line/area conversion, map editing, map imagery);
- linking GIS with other Windows applications (Excel, Word, Access).

All of the above exercises included extensive handouts and copies of relevant chapters from both the GIS and AutoCAD manuals. Additional exercises dealt more with the application of school mapping databases; for example, using the school point location layer to generate maps of school attributes such as number of students by gender and grade.

In addition, the above material has been collated into a GIS training manual. Several copies of this manual have been made available to the General Directorate of Building and Projects, to the General Directorate of Educational Planning, Research and Development, and to the Ministry in Gaza. The GIS training manual provides the Ministry

and existing trainees with a valuable resource which can be used to train other personnel, and is a major reference work for the design, construction, and manipulation of GIS databases.

(b) Validation of training

Phase five of the project specified that there would occur validation of all training provided in previous phases, and that trainees were to complete a 'train-the-trainer' session. Each of these tasks has been successfully completed.

Validation of all training provided has been assessed in the following manner:

- trainees have successfully completed critical tasks associated with the design and use of GIS databases;
- trainees have successfully demonstrated their ability to use facets of the GIS for the analysis of school mapping data (both geographic and non-geographic) for planning purposes.

Associated with the latter form of assessment has been the establishment of a Working Group in the Ministry to undertake a strategic planning exercise for the district of Qalqilia. The purpose of the Working Group was to utilize the school mapping databases and the GIS to assist with decision-making on the future distribution of educational resources in the district. All the trainees were involved in the Working Group, together with key persons from other divisions in the Ministry (such as Teacher Training and Supervision, School Facilities, etc.).

One additional measure of the success of the training programme has been completion of a 'train-the-trainer' session. This session was held at the Ministry office in Gaza during the period 2-7 January 1999. Three of the four top trainees undertook an intensive GIS training

session in Gaza under the supervision of the consultant. A total of eight trainees from the Gaza office were selected to undergo training by the three trainees from the central MOE in Ramallah.

The three trainees have performed with exceptional ability in training their counterparts in Gaza. Most of the training has been conducted in English, with Arabic interspersed throughout the sessions. They have a clear grasp of concepts and their applications, and are able to convey this learning to their colleagues in a very professional manner. There is no doubt that the Ministry has three excellent persons who will be able to train an additional cadre of personnel and who will act as resource persons for GIS in the Ministry.

(c) Training facilities and equipment

The project faced a number of practical, seemingly mundane but not unimportant, constraints. The GIS training programme was administered in the design room of the Building and Projects Directorate. These facilities were not adequate to meet the needs of the trainees or of the programme. For example, the room allocated was cramped and crowded, with computers, a plotter, desks, digitizer, and large drawing cabinet all located in a room which normally seated three persons.

Further, the number of computers provided for training during the initial stages was not adequate; some trainees were using computers specially purchased for the project, while others were using standard computers with inadequate memory and power to work with GIS. This problem persisted throughout the training, despite a reduction in the number of trainees. It was unfortunate that at least half of the trainees were required to use slow and outdated PCs with inadequate memory (RAM) to undertake GIS work.

A high-level General Director in the Ministry took steps in November 1998 to purchase additional computers and to establish a

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proper GIS training room. (This was prompted by complaints lodged by several of the trainees.) At the time of completion of the project, the computers had not arrived and no provision had been made to set up a training room which would also house all other GIS-related equipment (digitizer, plotter, printers, computers).

It is interesting to note that while the Ministry recognized the importance of the GIS project, it was unable to provide adequate space for training and adequate computing equipment for the number of trainees involved in the project. Further, many of the trainees were obliged to give higher priority to work associated with their existing position than to the work required for project training – a result of the inadequacy of facilities and of the urgent character of their daily work.

Most of the problems mentioned above stemmed from a lack of ownership of the project within the Ministry. While there were two Directorates involved with the GIS project, neither was willing to take responsibility for the project. As a result, very few decisions were made about requests for logistical support and equipment, or for changes to the composition of the trainees, etc.

Institutional capacity building

One of the core tasks of the external consultant was to ensure the sustainability and local ownership of the GIS programme. Evidently, the project donors, in particular the World Bank, were also concerned to ensure continuation of the programme. To this end, the local World Bank representative and its Middle East regional representative held several discussions with the relevant Directors-General and with the Deputy Minister of MOE to ensure continued support after official completion of the project. They, like the consultant, were assured that the project would continue and receive full support from the Ministry.

For his part, the consultant was able to convince the MOE that it must give serious support to the provision of adequate training facilities and up-to-date equipment such as computers and printers, and sooner rather than later. Further, the consultant was able to impress upon many in the Ministry that building and enhancing a GIS is a long-term prospect which incurs significant initial start-up costs, but also has recurring costs that need to be funded on an annual basis. The longer-term pay-off for the Ministry is an up-to-date GIS for enhanced school planning and management.

The strongest recommendation by the consultant was that the MOE establish a GIS unit within the General Directorate of Educational Planning, Research and Development. Further, it was recommended that the GIS unit be headed by the Head of the Division of Planning (who was one of the top trainees). This unit would be in charge of school mapping, and be the link to other General Directorates and to the districts (for both school mapping and training needs).

The Planning Division will initially utilize to its full functionality the GIS and school mapping databases for planning and management purposes; for example, as part of current efforts to implement the five-year plan and for micro-planning. In addition, the Planning Division is likely to have shared responsibility with Building and Projects for the extension of school mapping databases to other districts in the near future. These additional data will be shared with other Directorates, and with the districts, but are likely to be digitally stored in the Planning Division.

Following personal communication with the Ministry at end of May 1999, it has to be reported that the initial momentum generated in the Ministry has waned, and the recommendations of the consultant have not materialized. The Head of the Planning Division is currently undertaking all GIS work. This means that remaining persons (trainees) associated with the project are not utilizing the GIS and

school mapping databases. However, those trainees who were from the General Directorate of Building and Projects are using the larger-scale digital school site plan data and architectural drawings for design of school expansion and school rehabilitation.

The reason for this apparent lack of capacity building appears to stem from the urgency associated with the rehabilitation, construction and expansion of schools in Palestine. Even though the value of GIS is officially recognized, it has a lower priority within the Ministry as compared with building schools. However, this does not mean that GIS is no longer sustainable at the MOE.

It has also been brought to the attention of the consultant that the Head of the Planning Division and the Director-General of International Relations have been successful in incorporating GIS requirements into the first five-year national education plan (2000-2004). If successful, this plan will (among other things) provide the necessary funds to set up a GIS unit with appropriate computing equipment and training facilities. Further, this unit would be responsible for extending the school mapping databases to other districts and for integration of all data for planning purposes. Finally, the five-year plan also allocates funds for additional and advanced GIS training.

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CONCLUSION

The Palestine Schools Mapping Project had as its main objectives the development of school mapping databases and use of GIS, and the training of relevant personnel in the use and updating of these databases. The goal of the project was to provide the Ministry with the capacity and capability to develop rational and well-argued multi-year plans for new school construction and maintenance, thereby enhancing the school planning function within the Ministry.

This monograph has described how GIS is used in the Ministry to support the school planning function, the steps involved in setting up the system, and the capacity-building process that is needed to ensure sustainability and local ownership of the project.

At the level of data collection and assembly, there were very few difficulties experienced with the project; what difficulties were encountered had more to do with bureaucratic delays than with the data. In fact, one of the surprising characteristics of the project was the availability of excellent digital geographic data which had been expertly generated by other units in Palestine as part of the development of a land information system for that territory. This was recognition of the maturity that various Palestinian Ministries had achieved with regard to GIS skills and spatial data handling in the short time since the peace agreements. Hence, one of the main benefits derived from the establishment of a GIS in the MOE was to put it on a similar level with other Ministries which already had GIS capacity.

The major difficulties experienced by the consultant in setting up a GIS in the MOE centred on two areas: (i) training facilities; and (ii) ownership of the project within the Ministry.

As discussed previously, while there was recognition of the importance of the GIS project in the Ministry, there was no allocation of resources from within the MOE to facilitate training and learning, and to ensure that the project is permanently located within a department with appropriate office facilities, etc. The case for such facilities and capacity building was promoted by the consultant on many occasions, and also championed by the trainees at the highest level in the Ministry. Unfortunately, the benefits from such lobbying were not forthcoming, and have yet to materialize to this date.

Further, it was also unfortunate that the issue of who has charge of school mapping in the Ministry was not resolved prior to the departure of the consultant. In the initial stages of the project, school mapping was firmly under the control of the General Directorate of Building and Projects (the main instigators for the project). However, the General Directorate of Educational Planning, Research and Development had later claimed ownership of the project, but was also never able to deliver on requests for improved training facilities and computing equipment. There existed severe tensions between the two departments that unfortunately affected the GIS project.

As a result of the above difficulties, there occurred intervention on the part of the Deputy Minister. His decision was to locate the GIS project in the Division of Planning - General Directorate of Educational Planning, Research and Development. The day-to-day responsibility for school mapping and GIS was to rest with the Head - Division of Planning, a situation that exists to the present day. However, there is no GIS office or training room, and most of the facilities used in the training programme are idle at present. Maximum exploitation of the potential of GIS and school mapping appears to be a long-term prospect.

In spite of the above difficulties, there were some major benefits and advantages derived from establishment of a GIS for school planning in the Ministry. These are summarized below:

- a significant increase in the computing-skills base of those personnel involved in the training programme - these persons will be able to transfer their newly found skills to others in the Ministry, thereby improving overall levels of computing proficiency;
- a heightened appreciation of the importance of GIS for school planning at a micro level and at the level of strategic planning;
- an appreciation of the value of and applications of 'spatial analysis' to school planning problems;
- understanding of the integrated nature of GIS work, and of the need for co-ordination and collaboration between various departments in the Ministry;
- recognition that GIS can be used for many applications in the Ministry besides school planning and that, in the longer term, GIS will be the core of a school's asset management system;
- recognition that the maximum exploitation of the operation of GIS is a long-term outcome and one associated with a steep learning curve for responsible personnel; and
- the fact that the Ministry now has a GIS, means that it joins a very exclusive 'club' of GIS operators in Palestine, and will be able to market its GIS skills base to assist other PNA organizations.

In sum, the Palestine Schools Mapping and Maintenance Scheduling Project has been able to satisfy project objectives to a high level. It has established within the Ministry extensive GIS capabilities for school mapping and planning. The challenge now is to develop an innovative project, with a strong potential to improve educational planning at central and district level, to become an integral part of the Ministry and, in this way, to turn planning into a strategic exercise, relying on a strong database.

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The booklet

Decentralization is currently being advocated and adopted by a growing number of countries. Effective decentralization requires districts and schools to select priorities, allocate resources and monitor quality on the basis of relevant information. Generally, such information is available, through the school censuses carried out in all countries, but it is all too seldom used to guide the micro-planning process. This is linked, at least in part, to a poor presentation and lack of analysis of the data.

Computer software can contribute to making this data both more attractive and more comprehensible. One such tool is the Geographical Information System (GIS). An increasing number of ministries of education rely on GIS to strengthen their management information system, but its full potential to improve educational planning and management at central and decentralized levels has yet to be exploited.

The two studies in this volume relate the experiences of Ethiopia and Palestine respectively in integrating a GIS into the educational planning process. They were written by experts closely involved in setting up the GIS.

The studies cover a wide range of issues. They look at technical aspects and provide many useful hints on how to set up an educational GIS in a cost-effective way. They also address several other questions:

- In what way can a GIS serve to improve educational planning at central and local levels?
- What are the main constraints on the integration and widespread use of a GIS in educational planning at different levels?
- How can developing countries overcome these constraints? Is there a particular model that can be applied to countries with limited resources who nevertheless would like to improve their decentralized planning through the use of a GIS?

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